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British submarine policy 1853–1918

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Abstract

The submarine is used as a case study to examine British attitudes to developing naval technology. Study of the Royal Navy's submarine policy suggests that the Admiralty was less conservative and more able than is often supposed.

The British were thoroughly conversant with all significant developments in underwater warfare from 1853. There was an early, if abstract, appreciation of the potential of submarine boats, but a distinction must be drawn between adequate technical assessments of early submarines and inadequate appreciation of the strategic consequence of developments in submarine warfare.

Development of British policy was greatly influenced by restrictive agreements concerning the type of vessels to be built by the Vickers arms firm, by the character and personal beliefs of successive Inspecting Captains of Submarines, and by the Royal Navy's decision to resume partial responsibility for coast defence from the Army.

British experience is put into context by a study of the submarine policies of other powers. The importance of the coastal submarine to Imperial defence is discussed, the patrol submarine's influence on the British policy of blockade is assessed, and the failure to anticipate unrestricted submarine warfare examined. In the final chapter, the performance of RN boats in the Great War is set against pre— and post—war submarine policy.

BRITISH SUBMARINE POLICY 1853-1918

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Introduction

Between 1914 and 1918, U-boats sank 11,148,027 tons of British and allied shipping and nearly won the war for the Central Powers [1]. This bald statistic is a measure of the terrible impact of a new weapon of destruction. Quite simply, the submarine was and remains the single most dramatic innovation in naval history.

It upset the existing balance of naval power in a way that the Dreadnought, the ironclad – even the naval gun itself – had never done. It was more mobile than the mine, more insidious than the simple fish torpedo. It brought a new dimension to naval warfare, striking a heavy blow at British naval supremacy; and though no power hoping to gain command of the sea could do it with submarines alone, it offered predominantly military nations the means with which to hazard maritime lines of communication and supply without building a ruinously expensive surface fleet. By exposing merchant shipping to the continual danger of an unseen attack, the submarine made the new war at sea as terrible as the war to come on land.

It may seem perverse, then, for this study to concentrate on *British* submarine policy. French inventiveness forced the Royal Navy to build its own boats. American business sense provided the Admiralty with the means to do so, and it was German ruthlessness that made the new weapon so formidable. Great Britain, whose flag flew over of 75% of the world's merchant shipping as well as the battle squadrons of the most powerful navy ever seen, had more reason to fear the submarine than any of her rivals, and was nearly ruined because she failed to appreciate the true magnitude of the threat it posed. But the roots of Britain's failure lie in the naval history of the preceding 60 years.

[1] Arthur Marder, *From the Dreadnought to Scapa Flow: the Royal Navy in the Fisher era, 1904–1919* (Oxford 1961–70), V, 110

This study has two main aims: to explore the ways in which a complex organisation such as the Royal Navy adapted to new technology in an era of change, and to explain why that organisation was so poorly prepared for the submarine war of 1914–1918 that it was nearly humbled by the "weapon of the weaker power".

In structure, the thesis can be divided into two fairly distinct sections. The first, which consists of the long opening chapter and the first part of chapter two, looks at nineteenth century submarine policy in some detail and puts the history of British submarine warfare in the years 1900–1918 in context for the first time.

Underwater craft are used as a tool with which to explore naval attitudes to technological change because the submarine can be introduced as a control in an assessment of the degree to which the Royal Navy was open to innovation. The major inventions of the nineteenth century – steam, ironcladding, shell guns, rifling and breech–loading – combined to enhance the efficiency of the battleships on which British naval power depended. To a lesser extent the same could be said of the torpedo, which the RN expected to use in the melee of a fleet action. For this reason the Navy was more or less bound to adopt these inventions, sooner or later, whatever the level of conservatism and apathy in the service.

The Victorian submarine, on the other hand, was almost entirely useless to a naval power such as Great Britain. There was no pressing need for the nineteenth century Royal Navy to possess submarine boats. For this reason, British submarine policy can tell us much about the Navy's real attitude to technological change: whether RN decisions were based on technical or strategic assessments, and more particularly the degree to which moral revulsion and blind conservatism afflicted the naval hierarchy.

The Royal Navy's response to developing submarine technology in the years 1853–1900 has never been properly examined before, but the wealth of new evidence uncovered suggests that the Admiralty did not – as all earlier histories have argued – close its mind to the submarine. Nor did the RN sneer at the immorality of a weapon of sneak attack and base its policy upon an irrational distaste for underwater warfare, as popular works commonly suppose.

The Navy's conservative strategy was developed from a realistic policy opposed to innovation for its own sake. The Admiralty was generally well informed of developments in underwater warfare and made accurate technical assessments of most of the submarines built in this period, though

it never understood the strategic potential of underwater warfare. But the inability of its intelligence organisation to evaluate the progress made by the French navy in the 1890s, combined with a failure to appreciate the significance of the work being done by the American civilians John Holland and Simon Lake, left the RN vulnerable and forced it to place hurried orders for Holland type submarines in December 1900.

The second portion of the thesis deals with British submarine policy in the period 1901−1918, and though no less detailed it is somewhat more concise, the bare bones of the story being better known. Chapter three examines the construction history of the submarine and discusses the important part played by the Vickers arms firm in the development of British boats. The Admiralty's motives for granting Vickers an effective monopoly over construction are outlined, and in the second part of the chapter the degree to which the monopoly influenced the design of submarines built for the Royal Navy is assessed. Chapter four looks at British submarine personnel and the role played by successive Inspecting Captains of Submarines. By discussing the compromises forced upon the Admiralty as it attempted to recruit and train submarine crews, it offers a new perspective on the RN's puzzling belief that enemy submarines could not operate off the east coast of England or in the Atlantic by suggesting that serious under−estimation of crew endurance was directly responsible for neglect of the underwater defences of British ports and contributed to the lack of urgency shown in the development of anti−submarine warfare.

The early history of British ASW is dealt with in chapter 7, and the major theme of British failure to evaluate the true potential of submarine warfare is discussed in more detail in the fifth chapter, which examines RN attempts to assess a developing weapon by examining its performance in manoeuvres and in service with rival navies. In chapter six the submarine is placed in the context of contemporary British naval strategy, and its impact on both defensive and offensive operations is described. General naval ignorance of the type's potential, caused in part by the decision to make the submarine branch a closed service, delayed the incorporation of the submarine into the Navy's offensive strategy, while Admiral Fisher's unrealistic decision to resume full responsibility for coast defence from the army at short notice had the unwelcome effect of pigeon−holing underwater craft as defensive craft long after they were technically capable of operating offensively. The tardiness with which the RN recognised the role submarines could play in re−establishing a close blockade, and the failure to anticipate

German unrestricted submarine warfare, were both due in part to the tendency to identify the submarine as a defensive weapon.

The performance of RN submarines in the Great War only emphasised the existing strengths and weaknesses of British policy. Individual submarines performed extraordinary feats made possible by the excellence of pre-war training and the soundness of pre-war design. But in struggling to incorporate submarines into a coherent overall strategy, the Admiralty doomed itself to devoting resources to useless projects: the steam-powered fleet submarine, whose strategic value obsessed the surface fleet and obscured the tactical problems of using underwater craft in close co-operation with capital ships; the submarine monitor; and, eventually, the aircraft-carrying submarine. The inadequacy of British anti-submarine tactics was ruthlessly exposed. Only by looking in detail at submarine policy in the seventy years from 1853 to 1918 can we understand why the Royal Navy was taken largely by surprise by the submarine's performance in the Great War and fully explain why the British empire came so close to defeat by starvation.

Three earlier studies – Dr Alan Cowpe's *Underwater weapons and the Royal Navy, 1869–1918*, Dr David Henry's *British submarine development and policy, 1919–1939*, and Dr Michael Wignall's *Scientists and the Admiralty: conflict and collaboration in anti-submarine warfare, 1914–1921* – have helped to shape the present thesis. Thanks to these works I have felt able to exclude much that would otherwise have had to be written on the history of the torpedo, on the anti-submarine branch's activities during World War I, and on those classes of submarine, subsequent to the K-boats, whose development was begun before 1918 but which really belong to the post-war period.

The whole work has been read and criticised by my supervisor, Dr Geoffrey Till of Kings College, London, and by Commander Richard Compton-Hall of the RN Submarine Museum at Gosport. It has benefited greatly from the savaging it received. Mr Clive Trebilcock of Pembroke College, Cambridge, the historian of Messrs Vickers, has read and criticised chapters two and three. He also has the dubious distinction of being the first to suggest the study of British submarine policy to me. Nick Lambert of Worcester College, Oxford, very kindly supplied me with a copy of his analysis of the performance of British torpedoes in World War I. Finally, Richard Furlong and Andrew Wilton performed the arcane task of

computerising statistics and graphs. Remaining errors of fact, interpretation and typing are all my own work.

Abbreviations used in the text and footnotes

ABSP Arthur Marder, *The anatomy of British sea power: a history of British naval policy in the pre-Dreadnought era, 1880-1905* (London 1940)
Add.Mss. Additional Manuscripts series in the Department of Manuscripts, British Library
Adm Admiralty papers in the Public Records Office, Kew, and the National Maritime Museum, Greenwich
AMC Armed merchant cruiser
AS Anti-submarine
ASW Anti-submarine warfare
bhp Brake horse power
BNA *Brassey's naval annual*
CERA Chief Engine Room Artificer
CinC Commander-in-Chief
CO Commanding officer
Commodore (S) Commodore (Submarines)
Cowpe Alan Cowpe, *Underwater weapons and the Royal Navy, 1869-1918* (London University PhD, 1979-80)
DEY D'Eyncourt papers, National Maritime Museum
DNC Director of Naval Construction
DNI Director of Naval Intelligence
DNO Director of Naval Ordnance
DOD Director of the Operations Division
DSF Arthur Marder, *From the Dreadnought to Scapa Flow: the Royal Navy in the Fisher era, 1904-1919* (5 vols, Oxford 1961-70)
EBC Electric Boat Company
ERA Engine Room Artificer
FIC Foreign Intelligence Committee, the precursor of the Naval Intelligence Department
FG Arthur Marder (ed), *Fear God and dread nought: the correspondence of Admiral of the Fleet Lord Fisher of Kilverstone* (3 vols, London 1952-59)
FO Foreign Office papers in the Public Records Office, Kew
FP Fisher papers in Churchill College Archives Centre
Halpern Paul Halpern (ed), *The Keyes papers: selections from the private and official correspondence of Admiral of the Fleet Baron Keyes of Zeebrugge* (3 vols, London 1972-81)
GF British Grand Fleet
HSF Imperial German High Sea Fleet
ICS Inspecting Captain of Submarines
IGF Inspector General of Fortifications
IJN Imperial Japanese Navy
KP Keyes papers in the Department of Manuscripts, British Library
M-branch Mobilisation branch of the Royal Navy, concerned with manning
MM *Mariner's Mirror*
NID Naval Intelligence Department
NM Roger Keyes, *The naval memoirs of Admiral of the Fleet Sir Roger Keyes* (2 vols, London 1934-35)
NYPL New York Public Library
PRO Public Records Office, Kew
RA Rear Admiral
RMA Reichs Marine Amt, the German Navy Office

RN Royal Navy
RUSI Jo. Royal United Services Institution *Journal*
SM Submarine
SRLB Surveyor's recommendation letter book, Admiralty papers, Kew
TB Torpedo boat
TBD Torpedo boat destroyer
TH *Technical history of World War I* in the Naval Library, Ministry of Defence
TrINA *Transactions* of the Institution of Naval Architects
USN United States Navy
USNI Proc. *Proceedings* of the United States Naval Institution
WO War Office papers in the Public Records Ofice, Kew
W/T Wireless telegraphy

/ Submarine specifications depend on whether a boat is submerged or at the surface. The slash denotes surface/submerged specifications. Thus "displacement 198/220 tonnes" indicates a surface displacement of 198 tonnes and a submerged displacement of 220 tonnes.

Author's note

All *emphases* in quotes from primary and secondary sources are from the original.

Genesis

BRITISH SUBMARINE POLICY 1853–1898

An incident at Valparaiso, 1866

Valparaiso lies at the foot of hills that tumble towards the Pacific at about latitude 33° South. It is the second city of Chile and in the last century had a population of about 80,000, most of them supported by the seaborne trade around the Horn. Even in the 1860s the city was a cosmopolitan place, full of Italians and Britons, though German was the foreign language most commonly heard; the ships of a dozen nations swung at anchor in the bay. But the broad sweep of the coast offers no natural protection to shipping. The deep water harbour can be frighteningly rough, and has claimed vessels displacing more than 3,000 tons.

In 1866 Valparaiso was a city under siege. Two years earlier a Spanish naval squadron had siezed two guano–rich islands off the Peruvian coast; Chile was drawn into the subsequent hostilities as an ally of Peru, and Valparaiso was blockaded by six ships commanded by Admiral Mendez Nunez. Seeing that conventional naval power would not defeat the Spaniards, the Chileans searched desperately for novel weapons. Early in 1866, a group of patriots planned a torpedo attack on the Spanish squadron in the bay, and at the same time – possibly in connection with this scheme – two submarines were laid down in factories by the harbour wall. A German named Karl Flach supervised the construction of the larger boat; she was built rapidly and launched towards the end of April, a few weeks after Mendez Nunez had bombarded the city, causing $15,000,000 of damage to trade and merchandise and creating a profound sensation in

Europe. After her preliminary trials, the craft was submerged for experiment on the morning of 3 May with eleven people on board. So confident was the builder the submarine would be a success that he took his only son with him.

The boat had an anticipated underwater endurance of eight hours. When 4 May dawned and Flach's submarine had not reappeared, the alarmed Chileans turned for help to the British frigate *Leander*, flying the broad pendant of Captain Michael de Courcy, Commodore of a flying squadron detached from Rear Admiral Denman's Pacific command. The situation was already hopeless, for de Courcy reported that when "application was made to me for the aid of divers and diving apparatus... the spot where the torpedo had gone down was clearly indicated by air bubbles rising to the surface, which continued to rise during that day, gradually getting weaker towards evening, and which by Saturday morning had all ceased." [1] The inventor, his son, and nine crew were drowned.

Flach's submarine was a 45 foot long hand–cranked boat, armed with a short breech–loading 42–pounder gun and a 2.5 inch cannon carried in a waterproof cupola. She was designed to creep up to the blockaders unseen and bombard them with the 42–pdr, which could be fired while she was submerged. Despite the provision of primitive hydroplanes to control her movement underwater, however, the boat had the fault of many early designs, lacking longitudinal stability when submerged. It seems probable that she took on an uncontrollable forward inclination and, going down in 150 feet of water in the deepest part of the harbour, her sides must have collapsed under the increasing pressure.

Flach's craft was a fairly typical example of the nineteenth–century submarine. Built and crewed by enthusiastic amateurs, she was conceived to fulfil a specific tactical function, but lacked the most basic qualities of an efficient warship. Her motive power was inadequate and her weaponry dubiously useful. Insufficient attention had been paid to hull strength and to the difficulty of navigating submerged, blind and with zero buoyancy.

[1] De Courcy letter of proceedings no.18, 22 May 1866, Adm 1/5970. For the background to this story, see William Columbus Davis, *The last Conquistadores: Spanish intervention in Peru and Chile, 1863–1866* (Atlanta 1950), especially pp.285–6, 300–06, and Roderigo Fuenzalida Bade, *La armada de Chile desde la liberacion de Chiloe (1826) hasta el fin de la guerra Espana (1866)* (np, Chile 1978) pp.638–9. Bade names a German engineer, Benen, as the designer of the submarine. Flach's crew is said to have comprised five Germans, two Frenchmen, two Chileans and an un–named Englishman. The latter thus became the first Briton to die in a true submarine.

As an experiment the submarine was a failure; as a weapon of war she was useless, since the blockade of Valparaiso had been lifted before the boat was even launched – and by a bitter irony hostilities were suspended within a week of her loss. But this incident at Valparaiso shows British submarine policy at work. Commodore de Courcy, and the Navy, looked on as the inventor experimented. They took careful notes, but neither encouraged Flach nor showed enthusiasm for his design. The help they offered was too little, and came too late.

When it became clear that rescue was impossible, the Chileans asked de Courcy to raise the wreck. As his divers struggled, fruitlessly, to attach hawsers and chains to the boat, the Commodore cannot have known that his attempts at salvage were as close as the Royal Navy was to get to acquiring a submarine in the nineteenth century.

Inspiration, utilisation, limitations: a survey of submarine development in the nineteenth century

The first significant name in the history of submarine warfare is that of David Bushnell. The Yale graduate and his *American Turtle* were the inspiration, direct or indirect, for every subsequent attempt to construct a submarine, and although Bushnell himself drew on a vigorous tradition of submarine experimentation, it was his example that fired both his contemporaries and his successors. "An effort of genius", George Washington called it, while John Holland (a man with a better claim than most to be remembered as 'the father of the submarine') believed the *Turtle* to be "a remarkably complete vessel, by far the most perfect and effective submarine boat built before 1881." [2]

Bushnell was born in 1740 in Connecticut. At the age of 31 he went to Yale to read divinity, but instead immersed himself in the study of underwater warfare, his principle preoccupation being what would today be called mining. It was a common fallacy of the day that an explosion would

[2] Alex Roland, *Underwater warfare in the age of sail* (Bloomington, Indiana 1976) pp. 67, 70–4; Richard Compton–Hall, *Submarine warfare: monsters and midgets* (Poole 1985) p.93; John Holland, 'Submarine navigation' in *Cassier's Magazine*, marine number 1897 p.541

dissipate itself under water and do no damage to solid objects. Bushnell realised that, on the contrary, water pressure could be harnessed to determine the extent and direction of an explosion with devastating effect. He began his experiments by detonating 2lb gunpowder charges in the coastal waters off New England, and – spurred on by the outbreak of the War of Independence – quickly designed a much larger mine. In 1775 he and his brother built the *Turtle* to carry this charge into battle.

Bushnell was not the first man to construct a submarine boat, but he was the first to arm one, and the *Turtle* was the first underwater craft to go into action against an enemy. The submarine herself was a tiny one–man vessel whose exact description does not survive. In shape she resembled two turtle–shells joined together – hence the name – and she was armed with a 150lb clockwork mine secured via a lanyard to a detachable auger. The inventor intended her operator to paddle the little boat out to the anchorage of a British man–of–war, submerge, and drive the auger into the hull of the intended victim. The mine would then be released and the *Turtle* could withdraw to a safe distance while the clockwork fuse wound down.

The heroic attempt by Sergeant Ezra Lee to attach Bushnell's mine to the stern of the British 74 HMS *Eagle* is perhaps the best–known story in the annals of submarine warfare. Lee set out from the New York shore on the evening of 6 September 1776 and later claimed he had propelled the *Turtle* several miles down the harbour to the spot where Lord Howe's flagship lay off Staten Island, only to find that he could not make his auger bite into the warship's hull. It hardly matters that recent research [3] has shown Lee was probably nowhere near the *Eagle* on that or any other night, that he may well have been overcome by carbon monoxide poisoning, concocting his story in order to save face, and that American pride in Bushnell's inventiveness has ever since been allowed to obscure the facts. The extravagent tributes of Washington and Holland prove that Ezra Lee's exploits had inspired them. David Bushnell's example was more important than his achievement.

Twenty years after the *Turtle* set out to challenge the Royal Navy, another American designed a submarine for use against Great Britain.

[3] Compton Hall, op.cit. pp.88–94

Finding himself in France during the Napoleonic Wars, the civil engineer and portrait painter Robert Fulton presented a set of plans to the Directory of the French Republic in December 1797. Fulton proposed to build a submarine capable of attacking the men–of–war enforcing Britain's blockade of the French coast. Hoping to reap the rich rewards of prize money, he offered to finance the boat's construction himself.

The inventor's suggestion failed to arouse the Directory's interest, but his luck changed in 1799 when Pierre Forfait became Minister of Marine. Forfait was a naval architect and had himself designed a submarine as early as 1783; he was to champion Fulton's cause for the next two years. With Forfait's support, the American laid down a boat called *Nautilus* which he demonstrated at Paris and Brest in 1800 and 1801. The copper–skinned submarine was hand–cranked, but the inventor provided her with a collapsible sail for surface propulsion. She was armed with a mine–and–auger arrangement and incorporated many of Bushnell's innovations, but was 21ft long and carried a crew of four. Fulton was able to dive her to depths of 25–30ft and after some practice found he could retain rough control over her while submerged with the help of a pair of hydroplanes right aft – the first to be fitted to a submarine. In his more candid moments, though, the American would confess that his boat was "extremely difficult to manage." [4]

At one point the inventor received a government grant of 10,000 francs to refit his boat and take her out to attack the British, but the blockaders were (it has been claimed) forewarned by an excellent intelligence system [5] and the *Nautilus* was too slow and too unwieldy to close a target successfully. When Forfait was replaced by the more conventional Admiral Decres in October 1801, the French government lost interest in the invention [6].

[4] Wallace Hutcheon, *Robert Fulton and naval warfare* (George Washington University PhD thesis 1975) p.67, quoting Fulton to Volney et al, 12 March 1810

[5] Cf. warning letters to Captain Samuel Linzee of *L'Oiseau* (14 September 1800, Adm 2/140 and Linzee's reply of 21 September 1800, Adm 1/2067) and Admiral Lord Keith (19 June 1803, in Christopher Lloyd, ed, *The Keith papers III*, London 1955 pp.21–2). The warning issued to Linzee was made after a report on Fulton's submarine dated 9 September 1800 was received from General Gordon; see precis of miscellaneous secret papers, Adm 1/4362. The efficacy of these letters must be in doubt; *Nautilus* was at sea between Le Havre and La Hogue from 12–15 September. See also 'Admiral Lord Keith', 21 June 1803, digest cut 59–8, Adm 12/103; Hutcheon op.cit. pp.60, 62, 82–3

[6] Roland op.cit. pp.89–94; Hutcheon op.cit. p.84

The British were more concerned by Fulton's activities than they cared to admit, and in 1803 the inventor was offered a substantial financial inducement which brought him to London in April 1804. Interviewed by the Prime Minister, Pitt, and the First Lord of the Admiralty, Lord Melville, the American signed a contract which guaranteed him a salary of £200 a month in exchange for the exclusive rights to his inventions for fourteen years [7]. But the Admiralty had rather less faith in Fulton's submarine than had Britain's politicians; the agreement was never fully implemented, and Fulton returned to the United States in 1806 to devote his energies to the construction of the steam ships for which he is best remembered. Submarine warfare progressed no further for a number of years.

The inspiration provided by Bushnell and Fulton was important because it was cherished by a small group of engineers and inventors who had little else to encourage them. The story of Bushnell's *Turtle* seemed to prove that a submarine – even a tiny, man–powered boat – could attack a warship and be foiled only by bad luck; it inspired designers grappling with inadequate technology. Robert Fulton, on the other hand, was one of the most celebrated engineers produced by an age rich in engineering talent. His reputation and his acknowledged genius lent credence to the somewhat extravagent claims made for his submarine. Fulton's experience encouraged other projectors (a contemporary term for inventors) in the belief that governments could be persuaded to finance the construction of submarine boats, and his example encouraged his numerous successors. Since the first *Nautilus* was launched in 1800, at least seven boats have borne the name, from Jules Verne's fantastic creation to the world's first nuclear–powered submarine [8].

The British naval archives contain details of more than 300 submarine inventions submitted to the Admiralty between 1800 and 1900. The would–be pioneers who submitted such schemes had a variety of motives. Many sought naval approval and Admiralty money. A few cranks were

[7] Articles of agreement between Fulton and the British government, 20 July 1804, Adm 1/5121/22. See also Hutcheon op.cit. pp.84–88, 90, and E. Taylor Parks, 'Robert Fulton and submarine warfare', *Military Affairs* 21 (1962) pp.177–82.

[8] On Fulton's influence, see also Roland, op.cit. pp.120–33. So great was the American's fame that in February 1880 a man named Stevenson wrote to the Admiralty claiming to be Fulton's grand–nephew and requested remuneration for his great–uncle's inventions. The application was refused. 'Mr J. Stevenson', 25 February and 7 April 1880, digest cut 59–8, Adm 12/1060.

certain their inspiration was worth a considerable sum, and figures of £10–£15,000 were not uncommonly demanded for a look at some plans; in 1892 a Mr G. Buckley asked £200,000 for the rights to his submarine boat, suggesting that a pension of £500 a week be thrown in for good measure [9]. Thirty–seven years earlier, in 1855, the Surveyor of the Navy had rejected the plans of Cumberland Hill on the grounds that "the object of Mr Hill appears to be to get Employment in the Government Service." [10]

Imagination played an equal part. Man's desire to swim like a fish is as old as his wish to fly like a bird, and the sheer attraction of submarine navigation must be grasped before the effort put into the construction and development of underwater craft becomes intelligible. Indeed most competent inventors were not primarily motivated by commercial considerations. A significant number – the American Simon Lake prominent among them – envisaged the submarine as a tool for exploration. Lake, who turned an obsession into a successful business in the years before the First World War, designed submarines for salvage work, underwater mining and diving operations. His ideas were anticipated by Lodner D. Phillips, a Chicago shoemaker who built two successful craft on the Great Lakes early in the 1850s. Phillips suggested that his submarines would be useful for pearl–fishing and wrecking – that is, recovering valuables from sunken ships [11]. Without private funding, though, such inventors often turned to governments for financial support. The progressive modification of the Phillips and Lake submarines, which were fitted out with guns and torpedoes to make them suitable for military use, indicates a realistic appraisal of what was needed to interest the admiralties of the world.

A third group of projectors constructed submarines to perform very specific tasks. The press of war caused several boats to be built in desperate attempts to counter the overwhelming naval superiority of an enemy; the submarines designed by Bushnell, Flach and a Confederate

[9] 'Plans of a submarine torpedo boat' 29 November 1892, digest cut 11a, Adm 12/1241

[10] Surveyor's recommendation letter book [S.R.L.B.] 24 October 1855, Adm 92/18 fol.2; see also 'Submarine boat invented by Signor CA Regis', 18 August 1865, digest cut 59–8, Adm 12/765

[11] Description of 'Phillips' sub–marine boat', dated 3 January 1859, submitted to Sir Baldwin Wake Walker, the Surveyor of the Navy; Wake Walker papers WWL 1, National Maritime Museum.

The most accessible account of Lake's theories is *Submarine: the autobiography of Simon Lake* (New York 1938). Readers should note that while the book is broadly accurate in outline, it is unreliable in detail.

syndicate led by the New Orleans broker Horace Hunley and an inventor named James McClintock, are typical examples. Such projects achieved unusual prominence for two reasons: they were frequently backed by governments which tended, in wartime, to be less than usually critical of submarine devices, more tolerant of failure (in the short term at least), and more generous with funding; and they often saw action of a sort, thus coming to the notice of contemporaries and historians. Even the not–infrequent fatalities associated with such boats were significant from this point of view.

Wartime submarines were most commonly intended for blockade–busting. The colonialists, during the War of Secession, the French, during the Napoleonic Wars, and the Confederate states, during the American Civil War, were all blockaded by a powerful naval enemy. Innovation was suddenly at a premium, and Bushnell, Fulton and the McClintock syndicate all took advantage of this fact to secure official backing for their submarine projects.

The last notable use envisaged for underwater craft in the Victorian age was the infiltration of harbours and destruction of underwater obstructions. A submarine–cum–diving–bell built by the British naval architect John Scott Russell during the Crimean War was intended to breach the barrier at Cronstadt, which was holding up the Allied fleets in the Baltic. During the American Civil War a French inventor named Brutus de Villeroi produced a submarine with which the Federal navy hoped to attack the rebel base at Norfolk and destroy the formidable CSS *Virginia* while she was fitting out [12].

For all this activity, few significant advances were made in the first eight decades of the nineteenth century. Most inventors worked alone, and there was little continuity of effort. Such men generally lacked the necessary intellectual, technological and financial resources to build successful boats, and submarines intended for service in war were invariably abandoned when peace was restored.

It is important to make a distinction here between inspiration – which was freely available to the aspiring designer – and information, which was

[12] James Baxter III, *The introduction of the ironclad warship* (Cambridge, Mass 1933) p.286; *Official Records of the Union and Confederate Navies in the War of Rebellion*, series I vol.7 (Washington 1902) pp.488, 523–4

not. Many problems confronted the would–be submariner, and it was difficult to stomach continual frustration and disappointment forever. John Holland, the Irish–American inventor of the Royal Navy's first submarines, devoted nearly 40 years of his life to an obsession; few were prepared to make such a sacrifice. In the absence of official encouragement, moreover, an inventor's chances depended as much upon his persistance and financial resources as they did upon the merits of his creation.

The most obvious difficulty lay in finding a propulsion system capable of driving a submarine beneath the sea. Early inventors, including Bushnell and Fulton, favoured hand–cranking mechanisms and relied upon the muscle power of their crew. This imposed severe limitations: Fulton's best speed was some 2.5 knots, about the same as that obtained by the Confederate submarine *HL Hunley* sixty years later [13]. Other designers resorted to specially–designed oars which could (in theory) be feathered while submerged, but the 16–oared boat built at Philadelphia by Villeroi in 1861–2 proved so inefficient that she was converted to screw propulsion by the Federals during the American Civil War [14].

More promising were various proposals to make use of stored power. In the years 1858–9 a French naval captain, Simeon Bourgois, designed *Le Plongeur*, a 420–tonne craft, with the help of the constructor Charles Brun. They filled her to capacity with 23 huge cylinders of compressed air which drove an 80hp engine, but the British naval attache predicted she would not be successful, and he was right [15]. Though the first submarine to be built and systematically developed by a major shipbuilding power, the boat was grossly inefficient and capable of a maximum four knots submerged. A few years later James McClintock calculated that an engine fuelled by the 'ammoniacal gas' he had seen powering street–cars in New Orleans could propel a submarine along at five knots. The gas could not, however, be safely generated on board, and a commission of British naval officers stated that its storage would require "the greatest attainable

[13] Secretary of the Admiralty to Lord Keith, 19 June 1803, in Lloyd op.cit. III, 21–2 (London 1955); statement by James McClintock, 30 March 1872, FO 5/1372

[14] Louis Bolander, 'The *Alligator* – first Federal submarine of the Civil War', USNI Proc. 64 (June 1938) pp.845–54

[15] FO precis of Captain Hore's naval attache's report no.27, dated 23 May 1862, Palmerston papers ND/D/24/2, Broadlands Mss. (Department of Manuscripts, Southampton University Library); Henri Le Masson, *Les sous–marins Francais, des origenes (1800) a nos jours* (Brest 1980) pp.19–27

accuracy of workmanship... to prevent loss from leakage at joints, glands &c., and so to guard against the air in the boat becoming vitiated." [16]

Steam was harnessed to drive semi–submersible Confederate *David* torpedo–boats as early as 1862, but the furnaces needed oxygen which was, of course, in short supply once a true submarine had ventured under water. In the 1870s, however, the Lamm fireless engine was developed to power San Francisco street–cars and adapted for use on the London Underground Railway. It utilised latent heat and the Liverpool curate George Garrett fitted one in his 1879 submarine *Resurgam*, built at Birkenhead. Superheated water (which flashed into steam when released into the boiler) drove the little boat along at two or three knots. Similar engines were used to propel the four submarines designed by Garrett and built by a Swedish arms–maker, Thorsten Nordenfelt, in the 1880s; the partners claimed a submerged speed of five knots for their fourth and last boat [17]. The Lamm engine did, however, have serious disadvantages. It took fully three days to heat the reservoir, and no Nordenfelt submarine had an underwater radius of action of more than 20 miles. Prolonged or repeated travel submerged was therefore impossible. More significantly, the temperature inside a Garrett/Nordenfelt boat rose to over 100^{o} farenheit when the water was superheated. The effect this had on crew efficiency is easily imagined.

Electricity was the answer. The Frenchman Oliver Riou was the first to suggest it, in 1861; two years later the Confederate engineer Alstitt designed the first dual–propulsion submarine, envisaging a boat powered by steam on the surface and electricity when submerged. McClintock expended considerable effort in attempts to perfect an electric motor for his second submarine in the same year, but abandoned the idea as impractical and converted the boat for hand cranking [18].

Workable electric submarines were not really feasible until the invention of the storage battery, conceived in 1837 but not commercially available

[16] Captain Nicholson and Mr Ellis, RN, 'Report on a submarine boat invented by Mr McClintock of Mobile', 19 October 1872, Adm 1/6236 box II; see also *The Engineer*, 25 August 1871 p.131

[17] William Scanlan Murphy, *Father of the submarine: the life of the Reverend George Garrett Pasha*, (London 1987) p.234; Richard Compton–Hall, *Submarine boats: the beginnings of underwater warfare* (London 1983) pp.48–53, 64–71

[18] Compton–Hall op.cit. pp.72–3; statement by James McClintock, October 1872, Adm 1/6236 box II

until the 1870s. (The lead acetate battery used in the first British Holland craft was developed in 1880.) [19] Even then there were still significant problems to be overcome. The early cells were heavy, inefficient, and worryingly prone to leak poisonous fumes. The first modern electrically–powered submarine, built with government help by a Spanish naval lieutenant, Isaac Peral, in 1888, was not a conspicuous success, and the enquiries of the British naval attache revealed "the general opinion seems to be that the boat is a complete failure... Lieutenant Peral went down three times, but was never able to move more than a few yards." [20] It was the French who finally produced an efficient electric submarine. *Gymnote* was launched in 1888 and powered by a 564–cell accumulator battery which was perfected only after years of frustrating trial and error [21].

Then there was the problem of armament. Here too little useful progress was made before 1880, although a profusion of redundant systems clamoured for a projector's attention. Bushnell, Fulton, and the Polish inventor Stefan Drzewiecki favoured mines which could be planted under enemy warships as they lay at anchor, but which would have been useless against a vessel in motion. Drzewiecki, who built two quite advanced submarines in Russia (the first in 1877 and the second two years later) intended his boats to dive beneath a ship and release floating charges which would bob upwards and be trapped underneath the target's hull. All his experiments with this system failed [22]. Other submarine mining vessels were constructed by the British shipbuilder John Scott Russell (in the 1850s) and the American Oliver Halstead (in the 1860s); both designed submarines which carried divers and explosives to breach underwater obstructions. Holland installed pneumatic 'dynamite guns' in several of his early boats, planning to bombard his victims from an awash position or close to short range and discharge a projectile into the target's side from underwater.

[19] John Maber, 'The history of the electric battery', pamphlet P1001, Naval Library, Ministry of Defence.

[20] Captain William May, 'Spain – fleet, dockyards &c.', NID no.346, April 1893, Adm 231/22

[21] Le Masson op.cit. pp.44, 48, 50

[22] Captain Ernest Rice, 'Report, with tracing, of a submarine boat', 27 November 1880, Adm 1/6551; Consul–General Stanley, despatch no.3 Political, 29 January 1879, FO 65/1054

Phillips and Flach fitted submarine guns to their craft.

Other designers had their own ideas. Fulton and McClintock experimented with buoyant towed torpedoes. McClintock's original idea was to dive his submarine under the target, thus drawing an infernal machine onto the enemy's hull, but in practice he found it difficult to keep the device clear of its parent. Instead his syndicate converted *Hunley* to carry a spar torpedo. A 90lb gunpowder charge was secured to a 22ft yellow–pine pole projecting from the submarine's bow; it was to be detonated by the boat's commanding officer after he had rammed his target. The spar (which was also fitted to *Le Plongeur* and was successfully used by Russian torpedo boats in the war of 1877) had at least the virtues of simplicity and certainty; it was, however, at least as dangerous to friend as it was to foe, and the *Hunley* did not survive her famous encounter with the Federal sloop–of–war *Housatonic* on 17 February 1864 – the first (and for fifty years the only) occasion on which a submarine sank an enemy warship [23].

The pioneer submariners had to wait for the invention of the fish torpedo – a device that could strike at a distance and reduce a projector's dependence on the suicidal courage of his crew – to acquire a weapon of significant potential. For unless they could plausibly hope to do more damage to an enemy than to themselves, submarines would never (wrote Captain Domville, naval attache to France in the late 1880s) "be sufficiently a bugbear" [24].

The problem was, in fact, a little more complicated than it first appeared, and Robert Whitehead's celebrated torpedo – in service by 1869 – was not fitted to a submarine until 1885. This may seem odd, given the enthusiasm with which the weapon was adopted by many navies in the 1870s, but there were good reasons for the delay. Most obviously, those who could afford to purchase the inventor's expensive secret had no intention of fitting the Whitehead to submarine boats. The Royal Navy, which led the world in torpedo development during the 1870s, envisaged its use on board ocean–going warships, perhaps as a sort of long–range ram

[23] On the details of the *Hunley*'s armament, see Milton Perry, *Infernal machines: the story of Confederate submarine and mine warfare* (Baton Rouge 1965) pp.98–99 and Eustace Williams, *The Confederate submarine* Hunley *documents* (np Van Nuys, California 1958, typescript in the New York Public Library)

[24] Captain William Domville, 'France: guns and torpedoes 1889', NID no.211, December 1889, Adm 231/16

in the confused melees that were expected to characterise a war at sea. Britain's 3,000–ton *Mersey* class torpedo cruisers were the logical products of this policy. Other nations preferred small, manouevrable torpedo boats that could press home an attack at short range, but depended for their safety on speeds far beyond any contemporary submarine [25].

The 'secret' of the Whitehead torpedo – the balance chamber that enabled the weapon to travel at any set depth – was well guarded. Little or no information was made available to outsiders, and during the 1860s and the 1870s submarine inventors were kept in profound ignorance of the Whitehead's capabilities. Having paid £15,000 for the privilege of obtaining the inventor's plans, the Royal Navy was not about to reveal them to the world. The majority of its officers knew nothing of the torpedo's workings; neophytes were sworn to silence before being initiated into the secret, and only a handful of men fully understood a Whitehead 'fish' [26].

The torpedo was in any case a controversial weapon. The fate of the *HL Hunley* (destroyed by the explosion of her own torpedo) encouraged the widespread belief that all torpedo–armed submarines were seriously at risk every time they went into action. In 1885 the research station HMS *Vernon* remarked of the *Nordenfelt I* that "it remains to be shown how far this boat and those like her will stand the effect of a submarine explosion at a comparatively short distance." [27] Eleven years later, the officer commanding the French boat *Gustave Zede* suggested to Lord Charles Beresford that "when it fired its own torpedo the concussion could smash the boat." [28] Not until the French conducted careful trials in the 1890s was it acknowledged that a submarine was only endangered if closer than

[25] Alan Cowpe, *Underwater weapons and the Royal Navy, 1869–1918* (London University Ph.D. 1980) pp.26–8, 69, 71, 114–27, 172–81. Proponents of underwater craft often pointed out that Whitehead's torpedo was in effect a miniature automatic submarine boat; and indeed the German Navy considered in 1874 a proposal that the British inventor should design them a submarine. RH Stotherd, 'Report on the German torpedo establishments at Kiel and Wilhelmshaven &c.' 25 November 1874, GT Phipps Hornby papers PHI 109/3, National Maritime Museum. Similarly, the inventor Louis Brennan, designer of a short–range wire–guided torpedo for coast defence, suggested that he should build a submarine for the Royal Navy; Wilson memo 'Submarine boats', 15 January 1901, Adm 1/7515.

[26] Cowpe op.cit. pp.18, 35

[27] HMS *Vernon* annual report 1885 p.63, Adm 189/5

[28] *The memoirs of Lord Charles Beresford* (London 1914) I, 362

about 75 yards to a torpedo explosion [29].

Most importantly of all, the underwater discharge of Whitehead torpedoes was not technically feasible until the early 1880s. The technique of projecting torpedoes from submerged tubes was not perfected until the end of the decade [30], and the impetus for this development stemmed not from concern for the possibilities of torpedo–armed submarines but from a decision to place a ship's Whiteheads where they were least vulnerable to enemy gunfire.

It was, in short, impractical to arm any submarine with a torpedo tube before the middle 1880s, and for this reason Thorsten Nordenfelt at first planned to equip the *Nordenfelt I* with two Lay wire–guided torpedoes, which were mounted on deck. The Swedish arms tycoon also patented an electric torpedo of his own invention in 1883 before fitting his boat with a Whitehead tube in 1885. The Whitehead could only be discharged when the submarine was at the surface, the crew being required to climb out on deck to trigger the torpedo [31].

For a surface vessel, the problem of submerged discharge was one of protecting a 'fish' against the rush of displaced water caused by the ship's forward motion. For a submarine, the chief difficulty lay in compensating for the sudden loss of weight when a torpedo was fired. There is, in fact, no evidence that the *Nordenfelt I* ever discharged her Whitehead, and it was some time before early submariners felt happy about the idea of suddenly lightening one end of their delicately–trimmed craft by firing the weapon. In the early 1900s the Royal Navy got around the problem by arranging for a couple of heftily–built stokers to run for'ard carrying a heavy box at the moment a Whitehead was discharged. The less innovative French preferred to fit the experimental submarine *Gymnote* with two externally–mounted torpedoes, supplied without tubes and fixed by pylons to the pressure hull, where they were difficult to maintain and vulnerable

[29] Theodore Ropp, *The development of a modern navy: France 1871–1904* (Harvard University Ph.D. 1937) p.545; Le Masson op.cit. pp.50–1.

For American experiments (c.1894) see Frank T Cable, *The birth and development of the American submarine* (New York 1924) pp.100–01. For British experiments (1907), see section 7.2

[30] Cowpe op.cit. pp.71–82; Ruddock Mackay, *Fisher of Kilverstone* (Oxford 1973) pp.153–56. Experiments with submerged discharge were conducted by the Royal Navy's Torpedo Committee from 1870, but the tube was for years fixed and stationary.

[31] CW Sleeman, 'The Lay and other locomotive torpedoes', RUSI Jo. XXVII (1883) pp.63, 67–8; BNA 1887 p.406; Murphy op.cit. pp.93–4

to damage. Later French boats were fitted with a combination of tubes and external Drzewiecki 'drop collars', which permitted the torpedoes to be crudely angled [32].

But many projectors never got the chance to worry about weaponry. Keeping a submerged boat on an even keel proved an almost intractable problem. Submarines dive by taking in enough water to destroy their positive buoyancy, and (broadly speaking) they will then happily plunge to the bottom unless trimmed so that they become neutrally buoyant. For years it seemed almost impossible to maintain the longitudinal stability of so finely–balanced a craft. The Nordenfelt submarines, for example, were decidely tricky to handle when submerged because the water in their partially–full boiler tanks swilled about, upsetting trim. Nordenfelt, Lake and the Portuguese naval lieutenant Don Fontes Pereira de Mello (with *Fontes*, 1892) were among the designers who steadfastly refused to dive a submarine at an angle, as Holland recommended. Instead, their boats were stopped and carefully trimmed down until just awash, then clawed under by vertical propellers mounted on deck, for fear that the submarine might take on an uncontrollable forward inclination and dive to her destruction [33].

The solution to this problem eluded even the determined French. The trials of *Le Plongeur* were abandoned in the 1860s when it was realised that she was excessively unstable. At 140 feet in length, she was by far the largest submarine built in the nineteenth century. It took an hour to trim the boat for diving, and even then she showed a disturbing tendency to veer uncontrollably between the surface and the sea–bed [34]. Hydroplanes, which act as horizontal rudders to control a submarine's pitch, were fitted to many boats from the *Nautilus* onwards, but were rarely placed abaft the propeller where they were most effective. The *Gustave Zede* underwent six years of trials (1893–99) before her hydroplanes were satisfactorily arranged, and the problem was by no means solved by the time she was formally commissioned. In May 1899 the British Admiralty learned from a reliable source that she was "a failure, that her ever coming back from

[32] Le Masson op.cit. pp.48, 51, 59; Bacon report 'Drzewiecki discharge gear for submarine boats' 2 July 1901, Adm 1/7522

[33] Thorsten Nordenfelt, 'On submarine boats', RUSI Jo. XXX (February 1886) pp.159–60; 'A new submarine boat', *Scientific American* 66 p.137, 27 February 1892

[34] Captain Hore, naval attache's report no.11, 19 February 1864, Adm 1/5901

Marseilles, after her recent trip, was problematical, ...[and]... that she has never dived for more than eleven minutes, and that only once. That was during the trip back from Marseilles, and they thought they would go lower and lower and never come back again... the Captain is not at all happy..." [35]

The underwater endurance of early submarines was limited by more than simple reluctance to plumb the ocean depths. The physiology of oxygen consumption in enclosed spaces was not well understood in the nineteenth century, but prudence (and a not–unnatural fear of suffocation) encouraged most pioneer submariners to err on the side of caution when estimating the supply of air available to them. Many inventors, including Fulton, installed cylinders of compressed air, and without it submerged endurance tended to be measured in minutes rather than hours. Holland's *Fenian Ram* had air "for at least half an hour" under water [36], an early submarine designed in 1863 by the Russian photographer IF Alexandrofsky was credited with the ability to dive for 45 minutes [37], and the hour's grace claimed for a submarine built at Chicago early in the 1890s by the American George Baker was described by the British naval attache as "considerable" [38].

Such estimates were needlessly pessimistic. The tiny *Hunley* – 40ft long, 42 inches in the beam and crewed by eight hard–working hand–crankers – established an endurance record in the winter of 1863–4. Twenty five minutes after she had submerged the air was so foul that a candle would not burn, but the crew stayed down for more than two and a half hours [39]. Numerous disasters and near–disasters have since confirmed the surprising endurance of humans trapped in a submarine; the artificers who cut a hole in *K13*, a British boat stranded for 35 hours on the bottom of the Gairloch in January 1917, were almost overwhelmed by the Stygian

[35] Jeffreys to Egerton 27 May 1899, Adm 1/7422. (Jeffreys was DNO and Egerton the Captain of HMS *Vernon*.)

[36] Archibald to Thornton 20 December 1880, FO 5/1746 fols. 186–9. (Archibald was Consul–General in New York, and Thornton the British Ambassador to Washington)

[37] Arthur Wellesley, military attache's report no.9, 22 January 1873, Adm 1/6281; DW Mitchell, *A history of Russian and Soviet seapower* (London 1974) p.181

[38] Captain Gerald Langley, 'United States: Navy dockyards, materiel &c.', July 1893, Adm 231/22

[39] Personal account by WA Alexander in the New Orleans *Daily Picayune*, 29 June 1902, copy in RN Submarine Museum archives A1985/63

blackness of the air which escaped from her – but with it came 47 survivors [40].

Not until 1901 did Captain Reginald Bacon, the Royal Navy's first Inspecting Captain of Submarines, lock himself and two full crews in one of the submarines then building for the Navy at Barrow to measure their oxygen consumption. "Although we know better now," wrote Bacon in his memoirs, "it was then by no means certain that human bodies in close confinement did not give off poisonous exhalations." In the event, he and his men suffered less from the effects of vitiated air than they did from the efforts of "an elderly representative of the Holland company who had brought along a flute wherewith to while away the time", and who played on through the long watches of the night. "At the best of times the flute is not an inspiring instrument," recalled Bacon, "but the dirges to which we were treated that night, in the bowels of the submarine, I believe caused us all, ever after, to look on the flute with a large measure of personal enmity." [41]

The last great technical problem was that of submarine navigation. There were no charts detailing underwater currents. The thick iron pressure hulls and electric motors of a submarine combined to distort compass bearings, while the chances of makings accurate observations at the surface were restricted by the longitudinal instability of most early boats; periscopes were useless if a submarine could not be controlled at a specified depth. It was, therefore, difficult to attain the pin–point accuracy necessary for a succesful attack.

Contemporary appreciations made much of this point. Sir Astley Cooper Key, Senior Naval Lord from 1879 to 1885, thought "very little of any vessel intended to be navigated under water as it is not possible to see any distance," [42] and as late as 1902 a Major Marrow sent the Admiralty details of an invention to secure "immunity from submarine attack... inky

[40] Don Everitt, *The K boats: a dramatic first report on the Navy's most calamitous submarines* (London 1962) p.76

[41] Reginald Bacon, *From 1900 onward* (London 1940) pp.56–7. Further experiments were conducted by the RN as late as 1905, when Professor Haldane and 15 men shut themselves inside *A5* for 24 hours and emerged unscathed. Talbot diary 20 + 21 September 1905, Imperial War Museum 81/42/2

[42] Bound volume of reports on the 'Supposed Fenian submarine torpedo boat in the course of construction at New York', fol.25: Key minute to Archibald despatch Secret no.70, 7 January 1881, Adm 1/6551

fluids to be discharged to becloud and discolour the water surrounding the vessel to prevent a submarine from finding its whereabouts." [43] Alexandrofsky's boat was accounted "a failure inasmuch as it was found almost impossible to see a vessel at a distance of more than two yards," and the DNO, Lord Hood, drew the Board's attention to the problem with the remark: "The difficulty of seeing a vessel at a very moderate distance from an underwater boat, is one of the great difficulties, as it must be necessary to be frequently coming to the surface to ascertain one's position." [44] Several boats – notably those of the Holland type – were in fact designed to 'porpoise', showing themselves briefly at the surface to get their bearings and diving again before guns could be trained on them. The system worked, but the element of surprise was often lost, giving an enemy the chance to manouevre out of harm's way.

The failure to evolve an efficient motor, a useable periscope, an effective weapon and reliable hydroplanes had obvious and important consequences. It meant that early, hand–cranked submarines were very restricted in their choice of targets. Stationary vessels and fixed defences were the most probable victims. In 1873 Lord Hood observed that "a submarine boat might probably be of considerable value for destroying torpedo defences, but not so efficient nearly as a means of attack against vessels especially when in motion." [45]

Similarly, primitive submarines had a tiny radius of action – usually a few miles at best. The perspiring oarsmen who rowed John Scott Russell's submarine could manage no more than four miles without relief. Robert Fulton's *Nautilus* was rendered impotent when the British vessels it had set out to attack raised anchor and moved further out to sea, and the Confederate privateer submarine *HL Hunley* spent months waiting for a Yankee blockader to come within range; she could travel no more than twelve miles in a night [46].

[43] 'Immunity from attack from submarine vessels' 9 January 1902, digest cut 11a, Adm 12/1377

[44] Wellesley report no.9, 22 January, and Hood minute 8 March 1873, Adm 1/6281

[45] Ibid

[46] Scott Russell 'Memorandum for consideration' 28 January 1856, Palmerston papers GU/RU/1149 enc.1; Roland op.cit. pp.100–01, 103; Alexander's account 29 June 1902, RN Submarine Museum archives A1985/63

It can hardly be emphasised too strongly that, when applied to boats constructed during the nineteenth century, the term 'submarine' is quite misleading. Without an efficient periscope, any torpedo–armed submarine would have to attack while awash or at the surface, and complete submergence was, therefore, generally contemplated only when evasive action was required. Diving was an essentially defensive manoeuvre. An 1893 Intelligence Department report observed that "the idea of attacking under water actually is not believed to be practicable." [47]

At this transitional stage in her development, the submarine was really no more than a torpedo boat which relied for protection on her invisibility rather than her speed. "It would appear that no recent design aims at the production of a real sub–marine, or actual sunken vessel, but that all projectors now desire to construct a craft which shall be only partially submerged," noted Captain Cyprian Bridge in 1889 [48]. The American Holland submarines purchased by Britain in 1900 were subject to the same criticism: "The United States appear to have acquired a successful vessel," reported the NID in May 1900, "but she can hardly be called a 'submarine', being more of a 'submersible' type as it is apparently intended to navigate her awash until she gets under fire, but even then, she will have to come to the surface from time to time, so as to rectify her course." [49]

Most submarine builders therefore devoted themselves to designing boats with as low a silhouette as possible. (It was the inventor's boast that no more than 18" of *Nordenfelt I* was visible when the submarine was steaming on the surface [50].) It was this imperative, not some technical difficulty, that persuaded the early submariners not to fit their boats with decks and conning towers, the absence of which kept hatches only a few inches out of the water. This in turn severely restricted the commanding officer's field of vision and left the danger of swamping ever–present; steaming with the hatches closed, on the other hand, both officers and men

[47] Langley report 'United States: Navy dockyards, materiel &c.', July 1893, Adm 231/22

[48] Bridge minute 17 April 1889, Adm 1/6998

[49] Intelligence Department report 'Submarine boats', NID no.577, May 1900 p.5, Adm 231/31

[50] Statement cited in despatch from Horace Rumbold (HM Ambassador, Stockholm) 1 May 1882, FO 188/144

were denied fresh air and kept cooped up below while the vessel was at sea – usually in conditions so cramped and unpleasant that crew endurance was minimal.

That was why the Royal Navy had little use for the sort of submarines being built in the nineteenth century. It was a highly mobile, offensively–minded service. If submarines were taken seriously at all, it was as weapons of desperation and defence. Their low freeboard rendered them useless in the steep coastal waters of the British Isles, and they had neither the speed nor the weapons to attack warships on the move. They dived slowly, reluctantly, and for seconds rather than minutes, minutes rather than hours. On the rare occasions that a submarine lived up to her fine title, she was a menace to nothing but herself.

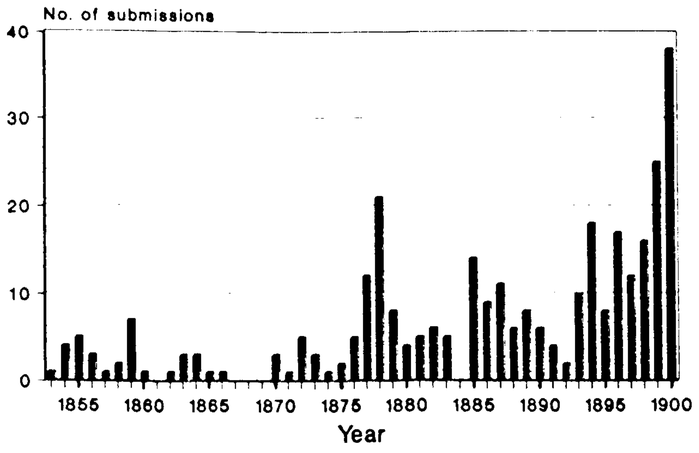
Wilhelm Bauer and the Prince Consort

Real British interest in submarine boats can be dated to the Crimean War. Only one communication on the subject [51] had reached the Admiralty in the first 16 years of Victoria's reign, but from 1853 a steady stream of inventions and reports were digested in the bulky volumes that record every letter and submission received by the Secretary of the Admiralty. The amount of business transacted by the Admiralty was huge, even in the relatively quiet years of the mid–Victorian era, and the proportion of that business which concerned submarines was, of course, tiny. But the Royal Navy soon became familiar with underwater weapons. As early as 1859 the Surveyor rejected Lodner Phillips' submission with the weary observation, "it does not appear that there is any great novelty in the plan or any advantage in it over the numerous propositions in regard to the construction of boats for similar purposes." [52]

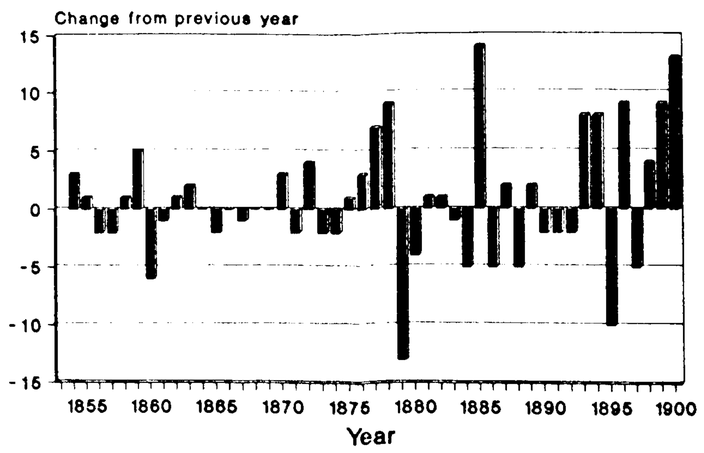
[51] 'Bassett's submarine gun boat' 9 August 1849, digest cut 59–8, Adm 12/509. During the research for this chapter, the Admiralty digests were searched for the period 1793–1900, and the Surveyor's Department records for the years 1812–1860. Three projects were submitted between 1800 and 1809, four between 1810 and 1819, two from 1820 to 1829, and none between 1830 and 1849. Aside from its dealings with Robert Fulton, the Admiralty did become involved in one other submarine project early in the nineteenth century: the RN's relationship with the submarine–builder Tom Johnson is described in Appendix 2.

[52] S.R.L.B. 2 June 1859, Adm 92/20 fol.591

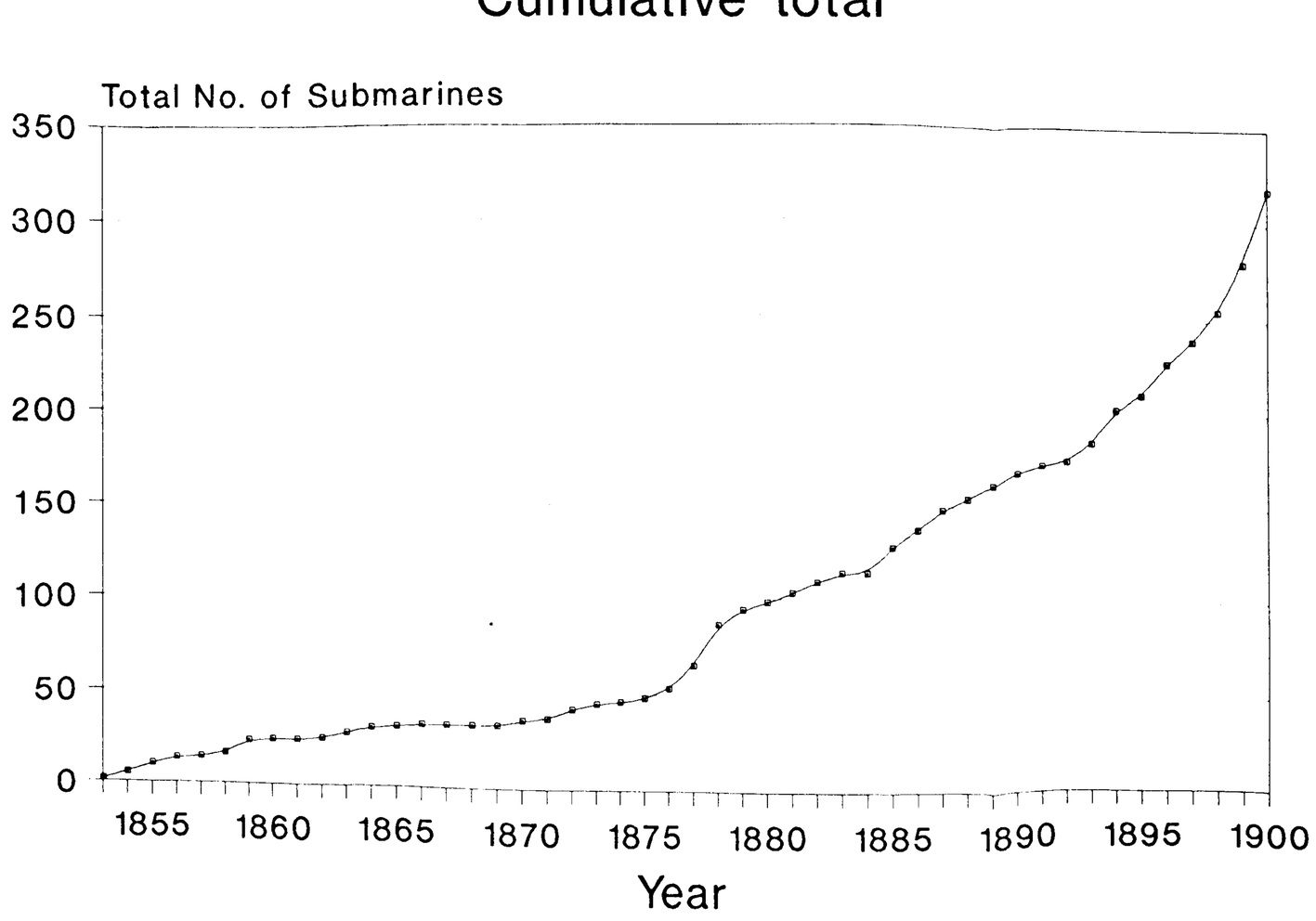
1a Submarine submissions
Total received annually by Admiralty



1b Submarine submissions
Annual change



1c Submarine submissions
Cumulative total



DISCUSSION

Graph 1a shows the number of submissions concerning submarines received by the Admiralty between 1853 and 1900. Data has been drawn from the Admiralty digests, cuts 11a (boats) and 59–8 (projects for annoying the enemy), and from the Surveyor's department records for the period 1853–1860. The latter series was discontinued in its old form in 1860.

The digest entries record all submissions sent to the Secretary of the Admiralty, and the Surveyor's papers all submissions sent to his office. If the Surveyor found a submission of some merit or significance he would submit a brief report on it to the Board of Admiralty; thus some of the Surveyor's records are duplicated in the secretariat papers. (I have counted duplicated submissions only once for the purpose of preparing these figures.) The less meritous of the Surveyor's submarine submissions were never seen by the Secretary of the Admiralty. In 1860 the Surveyor was elevated to the Board of Admiralty with the title of Controller, and thereafter all submissions were channelled through the Secretary – and, hence, into the digests.

The total number of submissions recorded between the inception of the Admiralty digest in 1793 [1] and the British adoption of the submarine in 1900 was 328 [2]. Of these, 318 were received between the years 1853 and 1900, an average of 6.8 per year. This statistic should be enough to dismiss the popular notion that the Admiralty remained in happy ignorance of the submarine until very late in the nineteenth century. It is, indeed, apparent that the Royal Navy was perfectly well-informed about developments in submarine warfare during the Victorian era. The use to which it put this knowledge is, of course, another matter.

Discussion of a simple average is, nevertheless, misleading, and the number of submissions received varied significantly from year to year. Notable peaks are recorded in the years 1878, 1885, and 1893–4, and from 1893 to the end of the century the number of submissions exceeds the average in every year. *Graph 1b* shows these peaks more clearly by illustrating the difference between each year's total and the number of submissions received during the previous year. Thus the *increase* in the number of submissions received in 1877 was 7, in 1878 it was 9 and in 1885 – the largest increase recorded – it was 14.

The probable significance of these peaks is debatable, but at least two appear to represent increased interest in submarine designs generated by popularly-reported trials of experimental vessels. The great increase recorded in 1885 was almost certainly the result of Nordenfelt's experiments with his first boat. The greater number of submissions made in the 1890s probably reflects the increased pace of development in France (note the peak in 1893–4, which coincides with the launching and early trials of the *Gustave Zede*) and the growing certainty that the development of a truly efficient submarine was just around the corner. *Graph 1c*, a cumulation of the 318 submissions received between 1853 and 1900, could legitimately be said to reflect in visual form the pace of nineteenth century submarine development.

Notes

[1] The scheme was worked out in the years 1808–1812, but the system was applied retrospectively to the correspondence from 1793 to 1808.

[2] For the record, the earliest submission (dated 14 September 1800) was a letter to Captain Samuel Linzee of *L'Oiseau*, warning him to be on his guard for Fulton's submarine. Digest cut 59–8, Adm 12/87; Linzee to Admiralty 21 September 1800, Adm 1/2067.

The first notable invention submitted to the Surveyor's Department was the 'hyponaut apparatus' devised by a Bavarian projector, Wilhelm Bauer, in 1853. But Bauer was evasive when questioned by the naval constructors Isaac Watts and Thomas Lloyd and refused to give details of the allegedly revolutionary engine that was to power his submarine. Predictably enough, the Admiralty was unimpressed by the invention [53]. On 26 August 1854, however, the Surveyor's Department took the unusual step of re-examining Bauer's scheme, asking no less a figure than Professor Michael Faraday to come to the Admiralty to interview him [54].

The Admiralty had several reasons for taking an interest in Wilhelm Bauer. Firstly, he was one of the few submarine inventors to have built a workable submarine and to have persuaded other governments to take him seriously. In January 1850, while an artillery corporal in the army of the Duke of Holstein, Bauer submitted the plans for a submarine boat to the Duchy's Ministry of Marine. He suggested that such a vessel might break the blockade instituted by Danish naval forces during the Schleswig-Holstein revolt, and persuaded the Ministry to allocate him 30 Prussian talers from the naval budget. With this money he built a large, clockwork-driven working model which was successfully demonstrated to an assemblage of notables. In due course a commission was charged with the construction of a full-sized boat.

The submarine was built at Kiel with the help of voluntary contributions from members of the army and local civilians. Named *Der Brandtaucher*, she displaced 30 tons and was manned by a crew of three - a captain and two crewmen who turned large treadwheels connected to a screw, driving the craft along at a maximum speed of three knots. Unfortunately for Bauer, a shortage of funds had forced him to weaken the boat's structure. On her first diving trial (1 February 1851) she shipped enough water through leaky glands to become unmanageable, and Bauer and his companions were lucky to escape alive from the stricken submarine. *Der Brandtaucher* was unsalvageable, and the inventor eventually left Germany for Austria and then Britain. By the time he reached London, Wilhelm

[53] Surveyor to Bauer 30 July and 5 August 1853, Adm 91/15; 'Bauer's hyponaut apparatus', S.R.L.B. 16 August 1854, Adm 92/17 fol.82. Brief details of Bauer's submarine may be found in his patent application (25 May 1853), copy in RN Submarine Museum archives A1853/1

[54] Surveyor to Bauer 24 August 1854, Adm 91/16; S.R.L.B. 22 August 1854, Adm 92/17 fol.82

Bauer had demonstrated his model submarine to Ludwig I of Bavaria, to his successor, Maximillian II, and to the young Austro−Hungarian emperor Franz Joseph [55].

The second and far more compelling reason for Admiralty interest in Bauer was the patronage the Bavarian secured from Prince Albert. Arriving in Britain late in the summer of 1852 he demonstrated his model submarine to the Royal family at Osborne [56], and Albert was sufficiently impressed to provide Bauer with the funds to construct another model when the first was lost. The Prince Consort had a lifelong interest in science and technology, took an interest in a wide variety of naval inventions, and was sufficiently unconventional to become a prominent proponent of Captain Cowper Coles' controversial turret ship a decade later [57]. The Bavarian's proposals gripped his imagination, and he became convinced that "it is '*a priori*' impossible that so important and new a fact as submarine navigation should be useless in the hands of men of genius." [58] By acquiring so powerful a supporter, Bauer ensured he would be treated with respect. Indeed the Admiralty's first contact with the inventor was made at the instigation of the Prince Consort, who wrote to Sir James Graham, the First Lord, to request a prompt investigation [59].

The RN's willingness to reinvestigate Bauer's proposals in 1854 may also be attributable to the fact that the German projector's plans took on a much more concrete form between July 1853 and August 1854. At Prince Albert's suggestion, he was introduced to the noted naval architect John Scott Russell late in 1853 [60]. Russell owned a shipyard at Millwall on the Isle of Dogs, and had made the Prince Consort's acquaintance two years earlier as secretary to the committee that had organised the Great Exhibition. By 1853 he was already engaged in building Brunel's singularly

[55] Eberhard Rossler, *The U−boat: the evolution and technical history of German submarines* (London 1975) pp.10−12

[56] *The Times* court circular 6 August 1852 p.5 col.c

[57] Stanley Sandler, *The evolution of the modern capital ship* (Newark, Delaware 1979) p.184; George Emmerson, *John Scott Russell: a great Victorian engineer and naval architect* (London 1977) p.84

[58] Albert to Palmerston 9 January 1856, Palmerston papers RC/H/59

[59] Albert to Graham 25 June 1853, microfilm 43, Graham papers, Cambridge University Library

[60] Rossler op.cit. p.12

ambitious *Great Eastern* – by far the largest ship yet laid down anywhere in the world – and as the inventor of the double bottom, pioneer of the wave–line system of shaping vessels, and co–founder of the Institute of Naval Architects, the Englishman was well qualified to help Bauer construct a new submarine [61].

Bauer moved down to Greenwich, and by August 1854 had fleshed out a new set of plans. Russell's contribution was to help the poorly–educated, intuitive Bavarian to present his ideas in a form acceptable to the Surveyor's Department, but no submarine was laid down in the Millwall yard prior to the submission of 26 August. Bauer and Russell may well have hoped to persuade the Admiralty to back the project before incurring major expense.

If so, they were unsuccessful. Bauer's lack of English (he spoke through an interpreter) and mistrustful nature combined to make him an unsatisfactory witness, and two days after the meeting he was "acquainted that his explanations have not been sufficiently distinct." Shortly thereafter Bauer became convinced that his co–workers were poaching his ideas. He had proved equally suspicious of French collaborators during a brief trip to Paris in 1853, but by now the Crimean War was under way and the inventor took himself and his plans to Russia. There, with the patronage of Grand Duke Constantine, the Minister of Marine, he built a large submarine, *Le Diable Marin*, which was intended to attack the Allied Fleet in the Baltic. This boat was quite successful and conducted numerous trials in the waters off Cronstadt [62].

Several interesting conclusions can be drawn from Bauer's experiences in Britain. The German inventor enjoyed some unique advantages which persuaded the Admiralty to take him seriously. No other projector could boast a powerful patron and a track record of government–sponsored submarine construction; none had the help of a respected naval architect and the resources of a major shipyard to back them up. From this point of view, it is unsurprising that those who followed in Bauer's footsteps did not enjoy even his limited success.

[61] Robert Rhodes James, *Albert, Prince Consort* (London 1983) p.185; Emmerson op.cit. pp.85–6

[62] 'Bauer's hyponaut apparatus' 28 August 1854, digest cut 59–8, Adm 12/589; Hans–Georg Bethge, Der Brandtaucher: *ein tauchboot – von der idee sur wirklichkeit* (Rostock 1968) p.36

It is, moreover, evident that when the Bavarian first arrived in Britain, the Royal Navy had no intention of building a boat to his specifications. The country was at peace, and the brief report submitted by the Surveyor's committee made it clear that Faraday and his associates were more interested in the inventor's 84hp "Gas–Steam–High–Pressure–Engine, in which Rocket Composition is to be used as the source of heat and gas" than they were in his submarine [63]. This preoccupation was fairly typical of the Navy's attitude to submarines in the Victorian era, and the Admiralty more than once showed considerably more interest in some feature of a submarine project than it showed in the submarine itself. In 1878, for example, the Navy requested details of the submarine developed by the well–known Liverpool shipbuilder Josiah Jones. The Admiralty was particularly intrigued by the boat's electric light, their Lordships being eager to ascertain whether it could really be made to work underwater [64]. This attitude suggests that – while there were so many technical problems to be overcome – the nineteenth century naval authorities were not much concerned with the submarine for its own sake.

John Scott Russell and Lord Palmerston

Bauer's departure for Russia passed unnoticed in the scramble to prepare a British fleet for operations in the Baltic. The Royal Navy had entered the Crimean War quite unprepared to meet the special problems that were to confront it; its line–of–battle fleet was unsuited to operations in the

[63] 'Bauer's hyponaut apparatus and gas engine: report upon', S.R.L.B. 28 August 1854, Adm 92/17 fol.83

[64] 'Submarine boat and electric light' 9 and 22 January, 2 February, 2 March 1878, digest cut 59–8, Adm 12/1023. Like many submarine projectors, Jones was a notable innovator in other fields. He had come to the Admiralty's attention in 1859 as the inventor of a system of inclined armour; cf James Baxter III, *The introduction of the ironclad warship* (Cambridge, Mass. 1933) pp. 162–3. Similar examples are legion: Fulton did significant work as a canal designer and proponent of the steam engine; Holland puzzled over the problems of mechanical flight; Bauer invented a 'camel' for use in salvage operations, and George Garrett the pneumataphore, a self–contained diving dress. James McClintock devised a machine for the manufacture of minie balls, while Simeon Bourgois was an early proponent of the screw propeller and a leading *jeune ecole* theorist. The first British submariners were no less original. Murray Sueter contributed to the development of the tank and claimed to have originated the concept of the torpedo bomber; Hugh Williamson was a major figure in the early development of the aircraft carrier.

restricted waters of the Gulf of Finland, and a host of unusual vessels had to be designed to meet these new conditions. Suddenly innovation was at a premium. Gunboats, mortar vessels, armoured rafts and floating batteries were built in numbers [65].

Meanwhile, the Russian 'fleet in being' at the great naval base of Cronstadt controlled the approaches to St Petersburg and prevented the Allied fleet from gaining command of the strategically vital waters of the eastern Gulf. Cronstadt itself was protected by a great barrier, several miles long, stretched across the shallows outside the harbour. The Royal Navy had to break through this barrier before it could attack the Russian fleet.

John Scott Russell revived the idea of building a submarine early in 1855. A new design was sketched with the help of the well-known civil engineer Sir Charles Fox, one of the principals of Fox & Henderson, the firm that had built the Crystal Palace. Together the two men drew up the plans of a large mobile diving bell to be crewed by divers and used to destroy the barrier at Cronstadt. Whether or not Russell had been examining Bauer's plans behind the Bavarian's back, the new invention bore little relation to *Der Brandtaucher* or *Le Diable Marin*. Bauer designed screw driven, completely enclosed boats. Russell's new craft, according to one officer who examined it, "was merely a large diving bell, like an inverted boat... It went down to the bottom with men under it; they were to walk along the bottom and propel the boat by pressing against against thwarts fixed to the under side." Crew members in diving dress were to leave the vessel and attach explosives to the target [66]. Russell and Sir Charles Fox seem to have drawn more consciously on the inspiration of a French designer, Dr Payerne, who built the submarine *L'Hydrostat* in 1846 and later converted her into a diving bell. In her new guise Payerne's boat was successfully employed in the construction of a breakwater for Cherbourg harbour [67].

[65] Baxter op.cit. pp.69–91; Andrew Lambert, *Battleships in transition: the creation of the steam battlefleet 1815–1860* (London 1984) pp.41–52

[66] Key at the Royal United Services Institution, 5 February 1886, RUSI Jo. XXX (1886) p.164; Andrew Lambert, *Great Britain, the Baltic and the Russian war 1854–1856* (London University Ph.D. 1983) p.280, citing Palmerston to Wood 17 December 1855, Halifax papers A4/63 fol.54, Borthwick Institute, York. Lambert has expanded on British naval policy in the Baltic in a recent book, *The Crimean War* (MUP 1990)

[67] See F Forest and H Noalhat, *Les bateaux sous-marins* (Paris 1900) vol.I pp.28–37. The Fox/Russell boat deserves the title 'submarine' insofar as it was both mobile and independent of any surface ship.

Whatever her deficiencies, Fox's and Russell's un-named vessel was the creation of two famous engineers, and with the war in the Baltic at a stalemate her inventors had little trouble in persuading Viscount Palmerston to sponsor the project. Like Winston Churchill in later years, the Victorian Prime Minister had a strong interest in novel military devices, and was excited by the possibilities of submarine warfare. The nineteenth century historian Herbert Paul observed that "there was no public man who could plausibly pretend to be more warlike than Lord Palmerston" [68], and according to Andrew Lambert, "Palmerston's enthusiasm for new weapons knew no bounds; he pressed every scheme that was sent to him onto the Admiralty and the Ordnance." [69] Disraeli noted in November 1855 that "Palmerston is for blowing up Cronstadt having got a discoverer who builds submarine ships worked by submarine crews, & who are practising on the Thames with, they say, complete success." [70].

The Prime Minister was unable to interest the Admiralty in Russell's experiments, but he told the inventors to press on and leave the problem of finance to him. This high-handed attitude drew an irritable response from the First Lord, Sir Charles Wood, who hastened to explain the Admiralty's position: "I do not quite understand from your note of yesterday what you have done as to Sir Charles Fox's proposed boat," he wrote in March 1855.

> "I understood before he was building... [her]... at his own risk to be bought or not as it turned out. If that is all you mean I have not a word to say. If you mean that you have authorised him to build his boat at the risk of the Govt., it is quite a different matter.
>
> "He has never brought any of the plans or information which... [I]... asked for when I saw him. We know enough of him to know that he is not a man to be depended on and we cannot be answerable for an expedition upon which we have not had the opportunity of forming an opinion." [71]

[68] Quoted in Bernard Semmel, *Liberalism and naval strategy: ideology, interest and sea power during the* Pax Britannica (Boston 1986) p.57

[69] Lambert op.cit. p.279

[70] Disraeli to Lord Derby 20 November 1855, quoted in Emmerson op.cit. p.86. The trials referred to were, in fact, conducted at Poole. (See below.)

[71] Wood to Palmerston 26 March 1855, Halifax papers Add.Mss. 49562 fols.27-8

With the support of Palmerston and Prince Albert (who had kept up his interest in submarine warfare), the Fox/Russell submarine was nevertheless ordered on 22 March 1855 and launched on 5 October [72]. She carried a crew of 12, most of whom were employed in sculling the boat along at her maximum surface speed of two knots. Russell hoped that his oarsmen would also be able to row the submarine while submerged but this dangerous technique was never tried, the boat's captain, Chief Diver McDuff (who had been strictly enjoined by Russell "to train his men gradually, and on no account drown any of them"), reporting that "there must be several descents before the men will have sufficient confidence to propel her under water; although they are willing, still they are timid." McDuff's caution was entirely justified. Although the submarine killed no-one, there were some exceedingly narrow escapes [73].

Anxious for secrecy, the designers sent the boat to the seclusion of Poole Harbour and persuaded a reluctant Admiralty to appoint a committee to examine their invention. The three officers selected were Captains Bartholomew Sulivan, Astley Cooper Key and James Hope. The first was a brilliant hydrographer, whose surveys of the Baltic and the approaches to Cronstadt had made him thoroughly familiar with the waters in which the submarine would have to operate. Of the latter two, Key (whose name had been suggested by John Scott Russell) was a noted technical officer and future Senior Naval Lord. Hope, another talented scientist, presided over the HMS *Captain* court martial and became an Admiral of the Fleet [74].

The initial investigation was not very thorough; the commissioners remained in London and contented themselves with examining the inventors, the captains of the submarine and her tender, and some Thames divers who testified to the difficulty of seeing any distance under water. Key, Sulivan and Hope then reported that although the boat might be useful in other circumstances, the murky waters off Cronstadt would preclude her successful employment there [75].

[72] McDuff's 'Journal of the submarine ship 1855', Palmerston papers GC/RU/1149

[73] Scott Russell to Palmerston 28 January 1856 and his enclosed 'Memorandum for consideration', ibid.

[74] Wood to Palmerston 17 December 1855, Add.Mss. 49565 fols.44-5; HN Sulivan, *The life and letters of Sir Bartholomew James Sulivan...* (London 1896) pp.372-3

[75] Albert to Palmerston 9 January 1856, Palmerston papers RC/H/59; Wood to Albert 31 January 1856, Add.Mss. 49565 fols.67-9

The matter might, perhaps, have ended there, but a copy of the committee's report was sent by Wood to the Prince Consort. Outraged that the three naval officers had not seen Scott Russell's craft in action, Albert wrote to Palmerston insisting that the invention should not be forgotten. Wood's response was to reconvene the committee, and late in January 1856 he sent its members to Dorset to examine the submarine.

Both Hope and Sulivan were optimistic that the boat would be a success in the clearer waters of the south coast, but they were severely disappointed by the trial that took place at Poole on 25 January 1856. While the Admiralty committee watched from Scott Russell's tender, McDuff and his crew completed a preliminary dive. Then they submerged again, and a buoyed air hose advancing slowly across the harbour marked their progress through the icy sea. After 20 minutes, the prow of the submarine suddenly shot out of the water, blew like a whale and went down again. Moments later the boat reappeared briefly before slipping back in a swirl of water. Soon those at the surface heard the sounds of a hammer being struck against the iron sides of the submarine. This was the agreed distress signal, and the craft was hurriedly brought to the surface by a safety line which Russell had thoughtfully attached to her beforehand. The crew were pulled out, gasping but alive, to explain that they had become stuck in a patch of Poole mud. McDuff had attempted to surface, but one of the two weights that had to be released snagged on some obstruction. The other end of the submarine rose unchecked to the surface and most of the air escaped. The Chief Diver's presence of mind saved his crew, for he gathered the men by one of the tanks of compressed air used to keep the sea out of the boat, and fed them oxygen while they waited to be rescued.

This concluded Britain's first official submarine trial. Not surprisingly, the Admiralty officers left Poole in what Russell termed "a state of considerable alarm and disappointment." They retrieved their earlier report, which they now considered too favourable, and submitted a second, more damning indictment of the submarine [76]. The boat was brought back to

[76] Scott Russell to Palmerston 28 January 1856, Palmerston papers GC/RU/1149; Wood to Albert 31 January 1856, Add.Mss. 49565 fols.67–9. There are two slightly distorted versions of events by members of the Admiralty committee; see Key's account in RUSI Jo. XXX (1886) pp.164–5; Sulivan op.cit. pp.373–4

London and left to rust [77].

On 31 January 1856, Sir Charles Wood sent the Prince Consort a summary of the committee's revised judgement. The officers had concentrated on three points, he wrote – the boat's qualities as a diving bell, her means of locomotion, and the difficulty of seeing any distance through the water. As a diving bell, they felt that Russell's craft had little to recommend her, and she was considered inferior to the Cherbourg bell and to the latest American designs. Nor was she fast enough to be useful in action. Finally, there still seemed to be very little chance of the submarine being used in waters clear enough for the crew to see where they were going [78].

Palmerston made one last attempt to involve the Royal Navy in what had been little more than a personal project of his by forwarding the bill to Sir Charles Wood. The First Lord was not amused. "I really do not know what has been gained by Mr Russell's experiment which was not known before, and actually in use before," he rejoined. "If we had undertaken the experiment we should have looked after it and paid for it. We knew nothing of its being going on, and never till I received your note yesterday that we were to pay for it. I have spent my last farthing of this year's votes and made no provision in the next. It would come I suppose under experiments, for we can make no use of the machine and I have no such vote as would cover a hundredth part of the expense." [79]

Two important conclusions can be drawn from this analysis of early British submarine construction. The first concerns naval and civilian attitudes to the new weapon. By 1856, the Admiralty had established a policy it would maintain for the next 40 years. The Royal Navy refused to sponsor Russell's project, believing (correctly) that the submarine would be a failure. In so doing it resisted strong pressure from the highest authorities in the land. The boat owed her existence to the private enthusiasm of Prince Albert and Lord Palmerston, both of whom were keen innovators and firm

[77] Delaney to Walker 10 January 1859, Wake Walker papers WWL1, National Maritime Museum

[78] Wood to Albert 31 January 1856, Add.Mss. 49565 fols.67–9

[79] Wood to Palmerston 19 March 1856, ibid fols.84–6. The cost of the submarine was about £10,000; 'Journal of the submarine ship 1855' (entry for 22 March), Palmerston papers GC/RU/1149

believers in the Victorian 'new technology'. Furthermore, Russell's craft was intended for a specific (and offensive) operation, the destruction of the barrier at Cronstadt, and would never have been completed had the country been at peace.

When Sir Charles Wood bowed to the wishes of the Prime Minister and the Prince Consort, he did so with good grace and ensured that the Fox/Russell boat was given a trial by highly qualified naval officers, just as the Surveyor had gone out of his way to secure the services of Michael Faraday in August 1854. For all their lack of initial enthusiasm, the officers appointed to examine the submarine made a sound assessment of her mechanical demerits. This pattern – considerable reluctance to become involved, *reasoned* resistance to the idea of submarine construction, civilian rather than naval enthusiasm for such projects, and the technical rather than tactical criticism of those that were investigated – was evident time and again during the next four decades.

The marked enthusiasm of civilian projectors for dramatic but impractical gadgets has been described by Lee Kennett [80]. Analysis of both the records of the Crimean War and the 44,000–odd inventions sent to the Munitions Inventions Department during the World War I suggests that front–line troops devoted their ingenuity to the development of defensive and protective equipment, while the inventions submitted by non–combatants were "overwhelmingly offensive", based on up–to–the–minute technology (electric death–rays in the 1850s, tanks and aircraft 65 years later) and intended to "destroy the enemy in some massive and spectacular way." The submarine projects of the Crimean War fit Kennett's model rather well.

Equally significant is the fact that the Royal Navy believed as early as 1855–56 that the development of an efficient submarine was inevitable. "There is no doubt in the world of the possibility of a submarine boat, as far as the existence of people inside her goes, or of the power of depressing or raising," Wood assured Lord Palmerston. "The questions are

[80] Lee Kennett, 'Military inventions and popular involvement, 1914–1918', in *War and Society* 3 (1985) pp.69–73. According to Guy Hartcup, only 30 of the 100,000 inventions sent to the Board of Invention Research during World War I "were likely to be of any use". The Munitions Inventions Department received 47,949, of which 226 were useful. The equivalent French body developed 781 of 44,976 inventions. Hartcup, *The war of invention: scientific developments 1914–1918* (London 1988) p.189

the means of propulsion and seeing and steering." [81] Less than a year later, the First Lord could envisage a solution to two of his three problems: "Locomotive power seems to me to have undergone a very insufficient trial," he informed the Prince Consort, "but I do not entertain any serious doubt of this being accomplished. There can be no more difficulty about a compass in an iron vessel under water than above water. The real obstacle to the use of these machines for offensive purposes is the difficulty of seeing under water in a horizontal direction." For this reason (and with peculiar forsight), the First Lord concluded his letter: "I am afraid that as far as the Naval operations of England are concerned they are more likely to be used against us than for us." [82]

Hope, Sulivan and Wood were not the only Admiralty officials with faith in the long-term future of the submarine. In May 1880 William Arthur, the first Captain of the torpedo school HMS *Vernon* and a member of the 1870 committee appointed to examine Whitehead's torpedo, declared that the construction of a successful submarine was certainly possible, and observed that "the capabilities of such a vessel would be great." [83] Arthur's colleague AK Wilson did not doubt that he was right, for "a very well thought-out design for a submarine boat was brought to my attention while commander of the *Vernon* about 1879, which only required only one small addition which any Torpedo Officer could have supplied to make it efficient." [84] These were not the sentiments of naval officers whose minds were closed to the possibilities of innovation.

1.3: INNOVATION IN THE VICTORIAN NAVY

Although the predominant image of the nineteenth century Royal Navy is still that of a service stagnating in the reactionary backwaters of ultra-conservatism, modern research has suggested that this view is

[81] Wood to Palmerston 10 May 1855, Add.Mss. 49562 fol.85

[82] Wood to Albert 12 February 1856, Add.Mss. 49565 fols.72-3

[83] Arthur naval attache's report no.26, 19 May 1880, FO 115/673

[84] Wilson memo 'Submarine boats' 15 January 1901, Adm 1/7515. It seems probable that the author is referring here to George Garrett's submarine.

inadequate. The Senior Service had its good and its bad points, it is true, but it is increasingly clear that its administration was broadly competent and its seamen never less than professional.

The Napoleonic Wars were, naturally enough, followed by a period of retrenchment, but Britain could not afford to rest upon her naval laurels much beyond the mid−1820s. The *Pax Britannica* was not an era of universal peace; the nation's resources were stretched by anti−slavery patrols off the coasts of Africa and China, by the host of minor wars fought in the name of policing an empire, and by the demands of maintaining almost a dozen naval stations overseas. Serious challenges to the supremacy of the Royal Navy had to be met from both France and Russia, and it was natural that Britain, the first industrial nation, should exploit her industrial supremacy to retain a lead over these naval rivals. As the century progressed it was the near−impossibility of matching the pace of technological change, not the difficulty of keeping faith with Nelsonic tradition, that most taxed British naval officers. NAM Rodger points out that "if the Victorian era had really been one of peace, they might have had the leisure to reflect on how to wage a future war, and not just on how to operate future equipment. If they had really been reactionaries, they might have held onto some of the hard−won wisdom of former generations. As it was, they were knowledgeable and enthusiastic proponents of technical change and material development who had lost sight of the objects for which the Navy existed: highly trained, and wholly uneducated." [85]

It is not difficult to evidence the statement that the Royal Navy was open to innovation for much of the nineteenth century. Far from being nostalgically wedded to the days of sail, the service was a comparatively early proponent of steam. The Admiralty authorised the construction of a highly experimental steamship in 1792. By 1800 there were engines at work in the Royal dockyards; by 1816 the First Lord, Melville, was urging the acquisition of steam tugs. Britain's first engined warship, the paddle−steamer *Monkey*, was purchased in 1821. By 1830 the RN was probably ahead of its nearest rivals, the French and United States navies,

[85] NAM Rodger, 'British naval thought and naval policy 1820−1890: Strategic thought in an era of technological change', in Craig Symmonds, ed, *New aspects of naval history: selected papers presented at the 4th naval history symposium, United States Naval Academy, 25−26 October 1976* (Annapolis 1981) p.149

in its employment of steamships [86].

The French replied with other innovations, notably the shell–gun pioneered by Henri–Joseph Paixhans. Britain tested a similar weapon in 1829 and adopted it in a limited way over the next decade; French interest was less concerted [87]. Other significant advances in ordnance followed later in the century. Rifling substantially increased the accuracy of naval guns and made long–range fire practicable for the first time. The Royal Navy tested early Armstrong rifles in 1858; in 1863 it accepted the disastrous 110–pounder breach–loader, which was simply too ambitious a product for its time.

The adoption of the Armstrong rifle demonstrated the naval appetite for innovation; its failure did much to dent this enthusiasm. The RN did not return to the breach–loader until 1881, and in the intervening period the quality of its gunnery fell behind that of its continental rivals. Gun calibre, however, increased rapidly in this period – from the 8–inch short–bore muzzle–loaders of HMS *Warrior* to the 12.5–inch muzzle loaders fitted in HMS *Dreadnought* (1875) and the *Benbow*'s 16.25–inch breach–loaders ten years' later [88].

More caution was shown in the development of the steam engine. The pioneer paddle–steamers were powered by large and inefficient single–expansion engines that were continually liable to breakdown and (mounted as they were above the waterline) catastrophically vulnerable to damage in any engagement. In addition, the sheer quantity of coal which the early steam engines consumed made trans–oceanic voyages impossible, and sail was necessarily retained as the principle motive power of the Royal Navy [89].

Not until Victoria's reign was underway did it become practical to provide sail line–of–battleships with auxiliary steam power. The development of the screw propeller made it possible to site engines in

[86] Ibid pp.146–7; Baxter op.cit. pp.10–11; Christopher Bartlett, *Great Britain and sea power 1815–1853* (Oxford 1963) pp.197–200

[87] Baxter pp.17–26, 69

[88] Ibid pp. 125, 131, 154, 197; Sandler, *The evolution of the modern capital ship* pp.99–100, 109; Marder, ABSP p.5

[89] Andrew Lambert, *Battleships in transition: the creation of the steam battlefleet 1815–1860* (London 1984) pp.18–19; Bartlett op.cit. pp.211–12; GA Osborn, 'Paddlewheel fighting ships of the Royal Navy', *Mariners' Mirror* 68 (1982) pp.429–33

protected positions below the waterline, and the screw hoist helped to guarantee reasonable performance under sail – impossible when a ship was fitted with bulky paddle–wheels. Once this problem was solved, the British became the first to fit their ships–of–the–line with screw propulsion [90]. Critics have nevertheless accused the Royal Navy of being over–cautious and reluctant to adopt steam as a motive power, and it is therefore essential to note that the eventual perfection of steam propulsion was by no means certain in the first two decades of the *Pax Britannica*. "Above all," writes Christopher Bartlett,

> "it was reasonable to doubt in the twenties whether the steamer would ever be able to fulfil the traditional requirements of the British capital ship – maximum fire power, maximum sea–worthiness, maximum solidity and maximum stowage capacity to enable it not only to fight, but to maintain a blockade in all weathers or voyage to any port of the globe. The only *tactical* and strategic advantage of the steamer at this time was its independence of wind and tide; on every other respect it was a less effective warship... The ultra–cautious introduction of steamers ...[in the 1840s]... could thus be justified – in no small measure – on the grounds of expediency, economy and technical ignorance, but only as long as no other power took the lead." [91]

The evolution of the wooden steam battleship has been traced by Lambert, who concludes that the Admiralty did an excellent, and suitably careful, job in producing vessels superior to those of its naval rivals in the 1840s and 1850s [92]. The Crimean War, it is true, exposed numerous deficiencies in naval organisation and naval personnel, but they were the defects of a service that had become too highly adapted to its peacetime role and which retained on its Navy List too many officers who had not commanded a ship for twenty years or more [93]. The Royal Navy's

[90] Bartlett op.cit. p.326

[91] Ibid p.206

[92] Lambert op.cit.

[93] Rodger op.cit. pp.142–4, 147–8

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performance in the later stages of the war was relatively impressive; innovation was strongly encouraged when it came to the host of small craft needed for the war in the Black Sea and the Gulf of Finland, though battleships were still produced with one eye on their long-term usefulness in the struggle against France [94].

Under Napoleon III, France was anxious to enhance both her naval prestige and her say in foreign affairs. The French navy of the Second Empire was efficient and innovative, and its new construction was in the hands of a man of genius, the naval architect Dupuy de Lome. His wooden steam battleship *Le Napoleon* (1850) and the ironclad *Gloire* (1859) forced Great Britain into a naval race she had hoped to avoid – but the Royal Navy was not slow to surpass the standards which de Lome had set. The British *Warrior* (1860) was a great advance on *Gloire*, whose armour concealed a wooden frame. *Warrior*, the world's first iron warship, was by common consent superior to everything that had gone before her [95]. Under the progressive leadership of two particularly conscientious projectors – Edward Reed, the Chief Constructor, and the Controller, Admiral Sir Spencer Robinson – the RN was able to maintain the lead the *Warrior* gave it throughout the 1860s. Sail, not steam, was now the auxiliary power of British warships. "If the Admiralty was certain of anything during the period of profound technical change that characterised the decade of the 1860s, it was that the sailing war ship was a doomed anachronism," concludes Stanley Sandler. "It cannot be said that the retention of masts and sails throughout the 1860s constituted a conspiracy of obstruction on the part of the Admiralty... It is the hindsight of a century that gives us perhaps a clearer view of the technical imperatives demanding the eventual total abolition of sails." Lance Buhl comes to a similar conclusion in his study of innovation in the post Civil War American navy [96].

The 1870s and early 1880s were a comparatively dispiriting period in British naval history. The so-called 'Dark Ages of the Admiralty' were an era of public disinterest, political interference and strict economy. Naval

[94] Baxter op.cit. pp.70–3; Lambert op.cit. p.43

[95] Baxter op.cit. pp.97–100, 109–11, 122–4, 158–60

[96] Sandler op.cit. p.78, 84–5; Lance Buhl, 'Mariners and machines: resistance to technological change in the American navy, 1865–1869', *Journal of American History* (1974) pp.703–27

conservatism might have been expected to flourish in this climate. Nathaniel Barnaby, the new Chief Constructor, was not a man of outstanding ability, and he was certain ironclad battleships and merchantmen were the only ship types required by a naval power. Sir Astley Cooper Key, who held the post of Senior Naval Lord from 1879 until 1885, was another who unconsciously espoused conservative values by devoting himself to routine administration to the exclusion of strategic planning. He did, however, substantially improve the *materiel* efficiency of the British fleet [97].

The Royal Navy's Dark Age weaknesses were exacerbated by the virtual absence of any naval threat. The French challenge all but vanished in the aftermath of the Franco–Prussian War; the US Navy was in an exceptionally moribund state; the German fleet was tiny and the Russians bedevilled by an unfavourable geographic position. But even the Dark Ages had their bright spots. The leaders of another age were beginning to make their mark; Jackie Fisher was one brilliant iconoclast who gained preferment in this supposedly reactionary period. Alexander Milne, who served as Senior Naval Lord between 1866 and 1868 and again from 1872 to 1876, was one of the most able men ever to hold the post, and Sidney Dacres, who headed the Board of Admiralty in the intervening period, was also entirely competent; he was also one of the few officers who advocated the total abolition of masts and yards. During the Dark Ages the torpedo was adopted and developed with an enthusiasm that overcame budgetary restrictions and resulted in the creation of the pioneering torpedo boat *Polyphemus*. Milne himself was responsible for the creation of rudimentary but not unrealistic war plans in the middle 1870s.

The slow decline in naval efficiency and enthusiasm inevitable in an era of monetary restriction and political restraint was ended by a series of violent invasion scares in the 1880s. The 'Truth about the Navy' panic of 1884, which was initiated by Fisher, HO Arnold–Forster, and the crusading journalist WT Stead, renewed public interest in maritime affairs and encouraged significant increases in the naval estimates, which were bolstered by the French invasion scare of 1888. The result was the Naval Defence Act of 1889, which laid down the policy of a two–power standard. Under

[97] NAM Rodger, 'The dark ages of the Admiralty 1869–1885', *Mariners' Mirror* 61 (1975) pp.331–44; 62 (1976) pp.33–46, 121–28; Ruddock Mackay, *Fisher of Kilverstone* (Oxford 1973) p.179

the guidance of William White, a naval architect of conspicuous ability, the RN began to build homogenous classes of first-rate warships in the late 1880s and 1890s. *Royal Sovereigns* and *Duncans* ruled the seas of the late Victorian era, and the renewed challenge of France and Russia, newly allied, was vigorously met. The torpedo boat, which many believed would threaten the supremacy of the battlefleet, was decisively countered by the British innovation of the destroyer – planned by the Admiralty but created, it must be admitted, by private industry [98].

This brief gloss is not the history of a stagnant service. Nor did the Royal Navy compare unfavourably with its major rivals. Despite the experience of the Napoleonic Wars and despite Paixhans' experiments in the 1820s, the French took four decades to adopt the shell gun [99]. Like the British, they displayed a suspicion of expensive iron warships in the 1840s, questioning the degree of protection offered and emphasising the dangers of splintering [100]. In the 1850s too many French warships were laid down without the step-by-step trials and experiments favoured by the UK, and the efficiency of the Frech navy suffered in consequence. France's steam warships were less advanced than their British rivals, and most were converted sail-of-the-line; even new construction continued to be wooden-hulled until the late 1860s, while the British turned definitely to iron hulls early in the decade. Royal Navy battleships of the period were superior in size, armament and in performance under sail [101].

The American navy failed to develop the lead in steam propulsion Fulton had given it after the War of 1812; Lance Buhl points out that "it did little more than conduct a distant flirtation with the weapon for nearly thirty years thereafter." [102] Steam remained auxiliary to sail in the United States, as elsewhere, until the outbreak of the American Civil War. And despite the impetus provided by this conflict, the United States did not capitalize on the dazzling innovations made during the early 1860s. The

[98] Mackay op.cit. pp.178- 9; Marder, ABSP pp.65-70

[99] Bartlett op.cit. pp.216-17

[100] Baxter op.cit. pp.63-4

[101] Lambert pp.97-101, Sandler op.cit. pp.44-46
It is interesting to note parallels with French submarine construction policy of the early 20th century, which was similarly biased towards the theoretical. See section 5.3.

[102] Buhl op.cit. p.704

submarine and the machine-gun were just two of the weapons developed during the war that remained unexploited for another half-century [103].

Having very briefly summarised almost a century of naval technical history, we are perhaps better placed to assess the British response to technological change. This response was not consistent and depended upon a variety of factors, some of them external to the Royal Navy and some of them internal. Obviously, both the political climate of the UK and the activities of foreign rivals were key variables. The stringent economies imposed by both Liberal and Tory governments during the 'Dark Ages' encouraged the retention of sails long after steam engines were technically efficient; coal was expensive [104]. Political expediency severely limited the funds available for experimentation and certainly precluded expenditure on weapons as esoteric as the submarine [105]. A desire to economise resources both financial and human underpinned Britain's 'wait and see' construction policy.

As the leading maritime nation, Britain had little incentive to innovate. As things stood she was supreme at sea; why should she introduce weapons or ships that might drastically alter the balance of power? This was the reason for British (and indeed French) unwillingness to adopt the potentially-devastating shell gun, for if the weapon lived up to its potential the navies of the world would have to armour their fleets at phenomenal expense and drain their treasuries merely to maintain a position which they already held. The introduction of any radical innovation potentially gave Britain's rivals the chance to start the naval 'race' again on even terms [106], and St Vincent's unequivocal response to the news that his Prime Minister had lured Fulton across the Channel to have him build underwater

[103] On US development of the machine-gun, see David Armstrong, *Bullets and bureaucrats: the machine gun and the United States army 1861-1916* (Westport, Connecticut 1982)

[104] Sandler op.cit. pp.17, 85-7

[105] The influence of economy on British naval policy has been widely stressed: cf. Semmel op.cit. pp.79-83; Rodger, 'British naval thought and naval policy' p.145; Sandler op.cit. pp.38-9, 79-80; Paul M Kennedy, *The rise and fall of British naval mastery* (London 1983) esp. pp.177-79, 193-4; Baxter op.cit. p.173; Lambert op.cit. p.60

[106] Bartlett op.cit. p.204, 216-17
This argument was, of course, commonly advanced when the RN introduced the *Dreadnought* design early in the 20th century. In this case, however, other navies were already planning very similar ships, and two decades of a naval arms race had increased public interest in naval affairs and made the governments of the day more willing to sanction the expenditure involved.

weapons for the Royal Navy was often quoted when this point was made. "Pitt was the greatest fool that ever existed," the Admiral is reported to have said, "to encourage a mode of war which they who command the sea did not want and which, if successful, would deprive them of it." [107]

In 1858 the Surveyor put St Vincent's policy in writing: "As I have frequently stated," he wrote,

> "it is not in the interest of Great Britain possessing as she does so large a navy to adopt any important change in the construction of ships of war which might have the effect of rendering necessary the introduction of a new class of very costly vessels until such a course is forced upon her by the adoption by Foreign Powers of formidable ships of a novel character requiring similar ships to cope with them... it then become a matter not only of expediency but of absolute necessity." [108]

The significance of this statement for nineteenth century British submarine policy is obvious.

The successful implementation of a strategy of 'wait and see' made it important that a careful watch be kept on foreign rivals, and Sir Baldwin Walker and his successors backed up the policy with an extensive programme of research and experimentation; no reasonable suggestion was rejected out of hand. A fine example of the open-mindedness (though some might say empty-headedness) of the Surveyor's Department may be found in the Admiralty's 1840 investigation of rubberised armour, a compound of rubber and cork which a Royal Marines lieutenant had suggested might be used to coat iron warships in the hope that it would deflect incoming shot and shell. Trials at Woolwich showed that the compound was useless; what is significant is that the Admiralty ordered experiments rather than condemning this unlikely-sounding invention out of hand [109].

[107] St Vincent, supposedly in an interview with Fulton during October 1805. It is entirely possible the quotation is apocryphal; we have only Fulton's word for it. What matters, however, is that St Vincent's adage was widely circulated in the 19th century and was widely accepted as genuine. See Alex Roland, *Submarine warfare in the age of sail* (Bloomington, Indiana 1976) pp.112-13

[108] Walker submission of 22 June 1858, quoted in Baxter op.cit. p.117

[109] Baxter op.cit. p.36

The Surveyor's Department's had an excellent record in such cases. The potential of iron armour was investigated with great thoroughness, the negative conclusions reached in the 1840s being drawn from six years' work and eight major series of experiments. In the 1850s similar trials were conducted to compare rolled iron, cast iron and steel before the navy decided on rolled iron plating for armour, and at the end of the decade puddled steel was also tried and rejected. Inclined (tumblehome) armour experiments were carried out in 1860 and the idea rejected for a variety of technical reasons which showed that under Walker and Isaac Watts, Britain's naval constructors were fully capable of conducting fair trials and drawing reasoned conclusions from the results [110].

There is no reason to suppose that the mid-nineteenth century Surveyor's and Controller's departments displayed significant bias in assessing new inventions, despite the pressures to which they were subjected. In the 1860s, for example, Reed and Robinson gave a fair trial to the controversial armoured turret warship promoted by the British inventor Captain Cowper Cowles [111] and the Swedish-American engineer John Ericsson [112]. The pros and cons of the armoured gun turret have been set out by Stanley Sandler, and it is plain that the controversy that swirled around the weapon had as much to do with party politics as it did with practical policy. From the Royal Navy's point of view, the principal defects of the turret were its weight, which lowered freeboard and therefore adversely affected seaworthiness, and a limited utility when fitted to an ocean-going warship; foc'sle, poop, masts and sails all cut down the arc of fire. In addition, the number of guns that could be carried in turrets was limited, and neither the weight of shot in a turret battleship's broadside nor its rate of fire bore comparison to the ferocity of an 'old fashioned' steam ironclad's short-range hail of shot and shell. These failings rendered the turret ship of doubtful value, and condemned it to remain so until rifling made accurate long-range fire possible and until masts and sails were largely done away with. The Navy's rejection of Coles's initial approaches was therefore sound. It was, moreover, tacitly supported by Britain's foreign

[110] Ibid pp.36-9, 118, 154, 162-3, 201-07

[111] Ibid pp.181-92

[112] Ibid pp.250-67

rivals; none built seagoing turret ships in this period [113].

The inventor and his powerful supporters were quick to condemn Admiralty 'conservatism', and the administration of the day was regularly berated in Parliament and in the press. There was undoubtedly resistance to technological change in the Royal Navy. An active list peppered with officers who had not been to sea for twenty years was unlikely to throw up many deviants from naval orthodoxy; employment was too scarce for many to risk going out on a professional limb. But the Victorian Navy had the nineteenth century's faith in progress, and this meant orthodoxy was never synonymous with reaction. Officers were cautious rather than incompetent, and indeed the Admiralty's own turret-ship, Reed's coastal ironclad *Devastation*, was a far more effective warship than Coles's disastrous *Captain* [114]. Conservatism was rooted in institutions and owed its existence as much to administrative problems as it did to the prejudice of individual officers [115].

The administration of the Navy was always open to criticism. The members of the Board of Admiralty were political appointees, and naval affairs were often caught up in inter-party disputes. The pressure of public opinion forced the Navy into several ill-considered political decisions. Equally significantly, the propensity of incoming governments to install their own Naval Lords meant that the average tenure of a Board of Admiralty between 1834 and 1871 was little more than three years [116]. Nor were the duties of the naval lords properly defined. Between 1832, when Sir James Graham reformed the administration, and 1869, when Hugh Childers became First Lord of the Admiralty, each member of the Board had two potentially incompatible functions. No distinction was made between the individual responsibility of the Naval Lords for the administration of their departments and their collective duty to oversee the administration of the Navy. This system made it impossible to assign responsibility for decisions to individual members of the Board, and in the absence of a staff and of London-based middle-ranking naval officers, the senior officers at the

[113] Sandler op.cit. pp.51, 179-80, 194-5

[114] Ibid pp.183-4, 192-4, 230-5

[115] Rodger op.cit. pp.142, 145, 147

[116] Sandler pp.41-3

Admiralty spent much of their time performing routine clerical duties. "By 1868," writes Rodger, "the Naval Lords had become mere administrators. The Board mechanism now existed only as an engine for dissipating responsibility." [117]

In December 1868, Gladstone made Hugh Childers First Lord of the Admiralty and instructed him to reduce the naval estimates and reorganise the administration. Many of the new First Lord's policies had merit; in particular, by introducing compulsory retirement for aged or permanently unemployed officers, Childers thinned out the Navy List and helped to produce a comparatively young and able generation of senior officers in the 1890s. But the First Lord did not understand the Navy and his decisions were based on political and economic preconceptions. His reform of the Board of Admiralty enhanced his own position, reduced collective discussion and responsibility still further, increased the amount of paperwork to be dealt with, and inhibited the development of strategic policy. Although some of Childers' more damaging reforms were rescinded by his successor, George Goschen, the influence of Gladstone's appointee continued to be felt well into the next century [118]. Not until the 1880s did the Admiralty regain some of the energy it had displayed in the 1860s.

It is in this context that we must view British submarine policy in the mid–Victorian period. This short sketch cannot, of course, do real justice to modern research on the nineteenth century Royal Navy. It omits much of importance, and necessarily glosses over many of the failings of the Senior Service – which was very far from perfect. But it does, I think, suggest that the institution was never unthinkingly reactionary [119], that it was relatively open to innovation, and that it was unlikely to reject the submarine as a moral outrage or a wild and hopeless fantasy.

British submarine policy 1856–1885

Underwater warfare evolved rapidly in the latter half of the nineteenth century. Mines and locomotive torpedoes were familiar weapons to a new

[117] Rodger, 'Dark ages' in *Mariners' Mirror* 61 pp.332–4

[118] Ibid pp.336–8, 342–3 and *Mariners' Mirror* 62 pp.122–3

[119] As Christopher Bartlett points out, "an intelligent conservative mind could speedily reinforce, and perhaps conceal, its prejudice with reasonable arguments against steam–power. Yet... a certain horse–sense was not lacking." Bartlett op.cit. p.205

generation of naval officers; Fisher and Tirpitz were among those who made their names in the torpedo services of their respective countries. In France a new school of naval thought, the *jeune ecole*, drew attention to the offensive possibilities of submarine weapons; in Russia, service in the torpedo branch meant prestige, accelerated promotion and better pay, and the officer corps was reported to be "enchanted with the torpedo boat" [120]. The British learned to be wary of Russian mines in the Crimean War, and the Federal Navy was taught the same lesson during the American Civil War. The Confederate Torpedo Bureau had more success than all the other rebel naval forces put together, sinking 29 enemy ships and damaging 14 more with mines and spar torpedoes [121].

The Civil War legitimised submarine warfare and emphasised its importance, and there was an appreciable upsurge of interest in the subject from the mid–1860s. In 1866 the Italians used mines to protect ports against Teggethoff's Austro–Hungarian fleet, and during the Franco–Prussian war minefields were sown to defend the German littoral against a materially superior French fleet. Russian torpedo boats scored striking successes with both spar and locomotive torpedos during the Russo–Turkish war of 1877–8. The Royal Navy adopted the Whitehead torpedo in 1870, and experimented fitfully with mines throughout the 1870s and 1880s.

The torpedo boat became the bogey–weapon of the mid–Victorian era. The first crude, spar–armed examples appeared when small but powerful steam engines were developed in the 1860s, and second class TBs were carried by many of the early ironclads. Improvements in the 1870s and particularly the 1880s led to the construction of larger, independent boats, lightly armed and armoured and dependent on high speed and raw courage to deliver their attacks – preferably by night.

Torpedo boats were popular with most navies in the late nineteenth century. The newly–unified German navy was among the first to develop the type, constructing semi–submersible spar torpedo boats in the early 1870s and – under the leadership of Tirpitz, who held the commission of Inspektion des Torpedowesens – a number of more conventional boats later

[120] Captain Beaumont report, quoted HMS *Vernon* annual report 1882, Adm 189/2 pp.129–34; Captain Henry Kane report 'Russian manouevres in the Baltic' 3 September 1884, FIC no.50, Adm 231/5

[121] Perry op.cit., appendix A

in the decade [122]. The invention of the fish torpedo made the TB more attractive, for until the development of ship–mounted machine guns and quick–firing artillery in the 1880s it proved difficult for ironclads to ward off torpedo flotillas that did not have to close to ram. The British Torpedo Committee of 1876 reported that neither gunfire nor torpedo nets, guardboats nor extra lookouts could prevent a determined torpedo attack [123], a state of affairs that eventually encouraged other naval powers such as France – which had belatedly began TB construction in the mid–1870s – to develop the weapon in the 1880s.

In the June 1884 manouevres, French torpedo flotillas launched the first full–scale attack on a fleet under weigh, closing to within 1,000 yards of their targets before being seen despite the disadvantage of a bright moonlit night, and coming under fire for less than a minute before discharging their torpedoes at a range of 400 yards [124]. This striking success encouraged members of the *jeune ecole*, a group of naval strategists who pointed out that France could not afford to maintain armed forces capable of opposing Germany on land and Britain at sea. The new school now suggested that French naval estimates could be reduced by abandoning the construction of capital ships and diverting resources into the production of fast cruisers and flotillas of cheap torpedo craft.

A sufficient number of cruisers could (it was suggested) bring the British Empire to its knees by disrupting a seaborne trade thought, in 1899, to be worth £710,000,000 per annum, while torpedo flotillas harrassed British commerce in the Channel and coast defence ships protected the rump of the French battlefleet. So long as the *Marine Francaise* had a fleet in being, argued the *jeune ecole*, the Royal Navy would have to institute a blockade of the enemy coast and would be unable to concentrate its resources on commerce protection [125].

[122] Charles Chesney report no.56, 'Submerged iron torpedo boats of Germany' 14 October 1871, Adm 1/6241; Carl–Axel Gemzell, *Organisation, conflict, innovation: a study of German naval strategic planning 1888–1940* (Lund 1973) pp.58–9; Mackay op.cit. pp.129–30

[123] Cowpe op.cit. p.19

[124] Ibid pp.119–20

[125] Geoffrey Till et al, *Maritime strategy and the nuclear age* (London 1982) pp.34–8; Bryan Ranft, *The naval defence of British seaborne trade, 1860–1905* (Oxford University D.Phil 1967) pp.23–7

The strategy was an attractive one for obvious reasons. France, it suggested, could strike at the heart of her old enemy's prosperity without attempting to wrest command of the sea from the RN in a decisive battle which most admitted would have to be fought on British terms. She could, moreover, do so cheaply (dozens of torpedo boats could be built for the price of an armourclad) and in the knowledge that a wholly disproportionate effort would be required to track down and despatch each raiding cruiser.

Sadly for the hopes of the *jeune ecole*, however, naval developments of the late 1880s and 1890s did much to discredit the torpedo boat. Later manoeuvres were inconclusive or downright discouraging; in 1887 the French flotillas failed to locate an enemy battle squadron – which had taken the simple precaution of dousing its lights by night – though they themselves were visible for miles, betrayed by the showers of sparks emitted by their over–heated engines. TB crews soon became exhausted; the efficiency of the flotillas declined swiftly after several days at sea in poor weather, and those torpedoes that were discharged sometimes acquired deflections of up to 15^{o} from the engine vibrations that shook the little boats [126]. In 1889, 1892 and 1893 the *defences mobiles* of the Mediterranean Fleet could not prevent 'Italian' squadrons from ravaging the French coast more or less at will [127].

British experiences with the TB were hardly more positive. In 1894 a flotilla attack on the battle squadron was adjudged unsuccessful despite being pressed to within 300 yards, and other torpedo boats attacked friendly warships. In 1895 Captain AK Wilson succeeded in blockading 'enemy' TBs in their harbour with a flotilla of newly developed torpedo boat destroyers, and British torpedo craft had no more success in the manoeuvres of 1896 [128].

The French nevertheless pressed ahead with TB construction. By 1893 a dozen torpedo boat stations were strung along the coast from Dunkirk to Brest, with more under construction in the Mediterranean, and 80 first class TBs were stationed in the Channel [129]. But useful as the new large

[126] Cowpe op.cit. pp.123–4

[127] Ibid pp.125–6

[128] Ibid pp.151–3

[129] Marder, ABSP pp.164–8

torpedo boats were admitted to be in coastal waters or the sheltered Med., they remained largely useless on the Royal Navy's high seas stamping grounds [130]. According to Alan Cowpe, the historian of the British torpedo service,

> "attempts to make the torpedo boat a seagoing threat to the battleship were discredited by the very manoeuvres designed to prove... [the]... thesis, while in its very reduced role as a harbour and coast defence vessel, the capabilities claimed by its advocates were never demonstrated in practice. The torpedo boat was repeatedly in difficulties merely steaming on the high seas, which dramtically reduced its claimed speed. By night, when it was reputed to be at its deadliest, the torpedo boat was often unable even to find the enemy." [131]

Although the Royal Navy continued to respect the Whitehead torpedo as a potent 'single blow' weapon possessing considerable moral effect and the ability to limit an enemy commander's freedom of action, it was, by the middle 1890s, coming to terms with the torpedo boat menace. Quick–firing guns, the TBD and the development of high–speed evasive tactics combined to make life in a surface TB dangerous and unprofitable, and a NID report on the 1895 manoeuvres quoted one naval officer who was of the opinion "that all the present types of torpedo boat are obsolete, and that probably no more will ever be built." [132]. Despite its advantages of high speed and low silhouette, therefore, the surface TB was – in the eyes of the RN at least – something of a spent force by 1900. The stage was set for the arrival of a different sort of torpedo boat.

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The naval authorities showed no special concern for the submarine between 1856 and 1885. They could have done so. There were always a multitude

[130] Ranft op.cit. pp.272–3, 283

[131] Cowpe op.cit. p.126

[132] Ibid p.152

of projects in progress at home and abroad, and a good dozen significant attempts to build workable boats were made in this period. The Royal Navy's interest in the subject was at best sporadic, and this suggests two things: that the Admiralty had an established conception of how a useful submarine would perform and what it should do, against which it measured the inventions which came to its notice, and that in the absence of such a machine the RN gathered information about imperfect vessels not because they constituted a threat, but because it wanted to learn something of the activities of its naval rivals. If this model is correct, we would expect the Admiralty to be more interested in underwater warfare generally than it was in submarines in particular, and anticipate that the Royal Navy would find indifferent national projects more compelling than useful but privately–built submarines.

The Admiralty's clandestine dealings with the Confederate submariner James McClintock support this interpretation of mid–Victorian submarine policy. Like Wilhelm Bauer, McClintock was a self–motivated and persistent inventor who had acquired considerable practical experience of underwater warfare. When the American Civil War broke out, he was the part–owner of a machine shop in New Orleans. With the financial backing of a wealthy lawyer and broker, Horace Hunley, McClintock and his partner Baxter Watson designed and constructed a small submarine at the Government Navy Yard. This boat, the *Pioneer*, was launched in February 1862 and underwent trials on Lake Pontchartrain. The inventors intended her to operate as a privateer, applying for and receiving a Letter of Marque. In April 1862, however, Federal forces captured the city and the submarine was scuttled to keep her out of enemy hands [133]. The *Pioneer* syndicate escaped to Mobile and within a few months had built a second boat, which sank in a storm while under tow off Fort Morgan late in the year. McClintock then designed a third submarine, named her for his principal backer, and sent her to the blockaded port of Charleston, where as we have seen she sank the Federal warship *Housatonic* on 17 February 1864 and was herself lost during the attack [134].

[133] 'CSS *Pioneer*', Royal Navy Submarine Museum archives A1872/23

[134] Perry op.cit. pp.90–108. *Hunley* hobbyists have never agreed on the identity of the submarine's designer; most assume from the craft's name that Horace Hunley himself was responsible, but McClintock's technical backround makes him a much more likely candidate ▶

The exploits of the Confederate submarine service were the stuff of legend, and Frederick Cridland, the British consul at Mobile, was one of many fascinated by the story of the *Hunley*. He succeeded in tracing McClintock to a dredger busy clearing the muddy waters of Mobile Bay, and in March 1872 obtained an interview with the Confederate inventor and forwarded a description of his submarine to the British authorities [135].

The Admiralty's response was cagey, and the consul was asked to "obtain all the information ...[you]... can on the subject, and if possible the opinion of American Naval Officers" [136]. In the face of the inventor's refusal to allow a Yankee access to his plans, however, it was decided to send the Flag Captain of the North American station to Mobile with his chief engineer so that a full report could be made [137]. At this stage McClintock, who had contrived without actually lying to give the impression he had a submarine lying in the bay, was forced to admit that the boat existed only on paper, and alternative arrangements were made for him to visit the *Royal Alfred* at Halifax.

On 18 October 1872 the inventor arrived on board the flagship of Vice Admiral EG Fanshawe, and in the course of a two–hour conversation Flag Captain Nicholson and the chief engineer, Josiah Ellis, were "strongly impressed with the great intelligence of Mr McClintock, and with his knowledge of all points, chemical and mechanical, connected with submarine vessels." [138] The persuasive Confederate even convinced them that, if only he had had better resources, "these submarine boats would have attained a terrible celebrity and materially have affected the course of the war."

Nicholson and Ellis concluded that "Mr McClintock's boat is capable of performing all that he promises of her, and we consider his invention of

◀ for the honour. According to McClintock's partner, Baxter Watson, McClintock designed the boat, Watson built it and Hunley and his associates paid for it. Letter from Baxter Watson II to Eustace Williams cited in Williams, *The Confederate submarine* Hunley *documents*, (np Van Nuys, Calif. 1958, typescript in the New York Public Library). But see also the contrary arguments advanced by Ruth Duncan, *The captain and submarine HL Hunley* (privately published, Memphis 1965; copy in the NYPL). Given the importance of McClintock's dealings with the RN, it seems worth noting that I tend to accept he was the *Hunley*'s designer.

[135] Cridland to Foreign Office 5 April 1872, FO 5/1372

[136] Cridland to Foreign Office 17 July 1872, ibid

[137] 'Submarine boat invented by Mr McClintock...' 9 August 1872, digest cut 59–8, Adm 12/897

[138] Fanshawe to Goschen 21 October 1872, Adm 1/6236 box II

the greatest possible value." [139] Admiral Fanshawe endorsed their report, and believing that submarine boats had an important future he suggested that "it would be very desirable to bring Mr McClintock to England and afford him with all the necessary means to construct, or superintend the construction of, a boat of good capacity according to his plans, at the public expense – which would not be great in comparison with the object." [140]

In December 1872 McClintock was invited to visit Britain and lay his plans before the Admiralty [141]. After a certain amount of hesitation, he refused the offer on the grounds that he could not afford to bring himself and his family to London because the trip to Halifax had cost more than $600. "If I should sacrifice my present means of support," he wrote, "and not make any definite arrangement with the Admiralty I should find myself in England in a very uncomfortable predicament." [142] British interest waned. The Royal Navy did attempt to persuade the Foreign Office to meet the inventor's past and potential expenses "from the secret service money" [143], but was simply not prepared to fund McClintock's trip itself.

What conclusions can be drawn from this unusually well–documented episode? The investigating officers were impressed by McClintock's expertise in underwater warfare generally, and drew attention to it in their report: "He produced two documents to shew the extent of the torpedo work he had done for the Government of the Confederate States," they noted, "we venture to submit that the vast experience he must have acquired in this work would be of great value to any government interested in perfecting a system of torpedo defence." [144] For its part, the Admiralty took the

[139] Nicholson and Ellis 'Report on a submarine boat invented by Mr McClintock of Mobile, US of America' 19 October 1872, ibid

[140] Fanshawe to Goschen, 21 October 1872, ibid

[141] Cridland to Foreign Office 3 January 1873, FO 5/1441

[142] McClintock to Cridland, letter dated 7 January 1873 but probably written late December 1872, ibid. When the Admiralty queried his seemingly excessive expenditure, it learned that "on Mr McClintock's return homeward he was seized with typhoid pneumonia at Bangor, Maine, and had to remain there confined to his bed for over six weeks. It appears that through a mistake a large quantity of morphine was administered to him in place of quinine. His recovery was not expected..." Cridland to Foreign Office 3 January 1873, FO 5/1441

[143] 'Inability of Mr McClintock to visit England...' 8 February 1873, digest cut 59–8, Adm 12/920

[144] 'Report on a submarine boat invented by Mr McClintock...' 19 October 1872, Adm 1/6236 box II. Similarly, Alexandrofsky's submarine was considered firmly in the context of ▶

inventor seriously because of this experience and because he had designed what they understood to be a successful submarine. The fact that the Flag Captain of the North American station had been detailed to leave his ship and travel several thousand miles to Mobile strongly suggests that the British authorities were suitably impressed by the wartime achievements of the Confederate submarines.

McClintock did not disillusion them. He carefully avoided mention of the *Hunley*'s inadequate armament and grisly safety record – she had drowned almost 30 crew members during trials – glossing over her destruction during the attack on the *Housatonic* as "a totally unnecessary part of the performance." [145] Significantly, too, the Admiralty was anxious to learn as much as it could about the submarine at the least possible cost. In 1872 the Royal Navy was subject to severe financial constraints, jibbed at the cost of bringing McClintock and his family to Britain, and met only a part of his expenses (he received $250). Despite the enthusiasm of its representatives on the spot, it is unlikely in the extreme that the Admiralty ever had any intention of paying the inventor to build a submarine.

Most projectors received less consideration from the British naval authorities than had McClintock. Those without practical experience of submarine warfare continued to be treated with scepticism, and though the Admiralty sometimes expressed tentative interest in schemes that seemed likely to reach fruition, it was always on the understanding that the costs of construction and the risks of trials were to be borne by the inventor [146]. Despite this caution, occasional disputes arose. In 1879 the Reverend George Garrett built a small steam–powered submarine, *Resurgam*, at his own expense and offered to put the boat through her paces before a committee of naval officers. His proposal was accepted, but while the submarine was being towed from Birkenhead to Portsmouth, the Manchester curate lost her in a storm. The boat had cost Garrett £1,400 to build, but when he asked the Navy to refund his costs the Admiralty replied by

◀ Russian expertise in underwater warfare. See William Houston Stewart minute 9 March and Admiralty to Foreign Office 15 March 1873, Adm 1/6281

[145] McClintock statement 30 March 1872, FO 5/1372

[146] Cf. 'Letter from Mr William Steel' 5 August 1812, digest cut 59–8, Adm 12/155; 'Mr Maguay' 19 February and 18 March 1878, digest cut 59–8, Adm 12/1023; 'Submarine torpedo launch submitted by Mr F. Windham' 4 May 1885, digest cut 11a, Adm 12/1138

denying responsibility, and a correspondence took place "relative to trials by Admiralty officers and alleged encouragement to Mr Garrett to build the boat." The authorities steadfastly refused to compensate the inventor, and in December 1880 rejected the further suggestion that he should build another submarine in exchange for £10,000 on the successful completion of trials [147].

The Admiralty ignored other would–be submariners completely. "You will be tired enough of projectors before you have done with them," Sir Charles Wood had warned Palmerston in 1855 [148], and the Royal Navy showed little patience with the majority of civilian inventors. It refused to send officers to Slough to inspect the 'patent submarine ship' built by Mr Henry Middleton [149], and turned down a request that naval officers be sent to Annapolis to witness the trials of Professor Josiah Tuck's promising *Peacemaker* [150].

Further evidence that the Admiralty was not especially interested in submarine projects that did not have the backing of one of its naval rivals can be found in an examination of the early career of John Philip Holland. Born in 1841 in County Clare, Holland emigrated to the United States at the age of 32. He took with him the rough plans for a submarine boat drawn up during the years he had spent instructing children in mathematics and mechanics at schools run by an Irish teaching order, the Christian Brothers [151]. Soon after his arrival in America, Holland began to cast about for backers. The inventor's most likely source of funds was one of the then–active Fenian societies, and in 1876 his brother Michael introduced him to just such a group of people: Jeremiah O'Donovan Rossa and the leaders of the Fenian Brotherhood. These men were impressed by the possibility of striking a blow at Britain's maritime supremacy, and

[147] 'Submarine invention – Revd GW Garrett' 8 April 1878, digest cut 59–8, Adm 12/1023; 'Revd. GW Garrett's submarine torpedo boat' – precis dated 8 April 1878 in digest of 1880, cut 59–8, Adm 12/1060. See also William Scanlan Murphy, *Father of the submarine: the life of the Reverend George Garrett Pasha* (London 1987). Although of a fairly advanced design, Garrett's little boat had no ballast tanks and no weapons system. Prolonged dives and effective attacks were therefore out of the question.

[148] Wood to Palmerston 26 March 1855, Add.Mss. 49562 fols.27–8

[149] 'Mr Henry Middleton's patent submarine ship' 12 November 1888, digest cut 11a, Adm 12/1186

[150] 'Professor Tuck's submarine boat' 12 January 1887, digest cut 11a, Adm 12/1170

[151] Donal Blake, 'John Philip Holland: his connection with the Christian Brothers', privately published paper in RN Submarine Museum archives A1985/49

Rossa's Skirmishing Fund agreed to finance the submarine project.

Holland set to work, building a working model and then a tiny steam–driven submersible 'canoe', 14ft. 6in. long and crewed by a man in a diving suit. She worked sufficiently well for a much larger boat to be laid down. This craft, the *Fenian Ram*, was built in New York City by Delamater's Iron Works at a cost of $20,000. She displaced 19 tons, had a crew of three, and was powered by a 15hp Brayton petrol engine. The boat was armed with a pneumatic 'dynamite gun', and upon her completion in 1881 made some well–publicised cruises around New York harbour. Eventually, in 1883, Holland's backers grew impatient at the slow progress of trials and took possession of the submarine. They were, however, unable to operate her successfully, and in October 1883 the British Vice Consul found the *Ram* tied up and neglected at Sewer Dock, in a disreputable part of the harbour.

The British consulate had begun to take an interest in the *Ram* in March 1880, while she was still under construction at Delamater's yard. Both the British naval attache, Captain William Arthur, and Consul General Archibald visited the shipyard while the submarine was building, and although initially sceptical of rumours that the Fenians were behind the project, they quickly obtained evidence that this was indeed the case [152]. Private detectives were employed to keep track of the submarine, and Archibald himself took the trouble of establishing a relationship with Cornelius Delamater [153]. The contractors allowed Captain Arthur to copy Holland's plans [154], and (perhaps by citing the *Alabama* claims) British officials persuaded the US customs authorities to keep a watch on the submarine: "The American government will do anything to carry out the wishes of Her Majesty's Government with regard to this and any other such plans," noted Vice Consul Drummond [155]. British and American officials

[152] Arthur naval attache's reports no.12, 5 March 1880, and no.26, 19 May 1880, FO 115/673 fols. 18–19, 55–6; Thornton to Foreign Office 24 May 1880, FO 5/1745 fol.266

[153] Archibald to Thornton 20 December 1880, FO 5/1746 fols.186–9; Pierrepoint Edwards (Vice Consul, New York) reports political no.35, 14 July 1881, FO 5/1778 fols.315–19; political no.39, 20 July 1881, ibid fols.343–5; political no.41, 25 July 1881, ibid fols.367–72

[154] Arthur naval attache's report no.90, 2 August 1881, FO 115/673 fols.209–10

[155] Drummond (Vice Consul, New York) telegram 3 September 1881, FO 5/1780 fol.13; see also Foreign Office to Drummond 12 September 1881, ibid fol.32; Admiralty summary of Drummond report secret no.223, 1 August 1881, in bound volume of reports titled ▶

watched the *Fenian Ram* for two years, until she was "rusted so she is hardly good for anything... [and] there was some talk of her being sold for old iron." [156].

Britain's diplomats took the *Fenian Ram* far more seriously than did the Admiralty. The Foreign Office sustained a major intelligence operation directed against the several Fenian societies from the 1860s to the mid 1880s, when the Nationalist clamour began to diminish. It was forcibly convinced by a variety of terrorist outrages that the Irishmen represented an appreciable threat. To the Foreign Office the submarine was important because it was a Fenian project, and the New York consulate displayed little interest in her until Holland's links with the Skirmishing Fund were made clear.

The Admiralty approached the problem in a different way. It was prepared to take Holland seriously because of his links with the Fenians – indeed the DNO, Hopkins, minuted that "we should have the authority to take possession of this vessel whenever she gets under our jurisdiction" [157] – but the RN was more interested in the submarine's technical shortcomings than in her political significance. From this point of view, the *Fenian Ram* was not much of a threat. Although (unusually) she performed satisfactorily under water, the submarine was terribly slow, and her weapons system was never perfected. Holland thought of her as no more than an experiment; he intended to build bigger, better boats at a later date. While the Foreign Office was spending heavily on private detectives, therefore, the Director of Naval Construction judged that "there seems no reason to anticipate that this boat can ever be a real danger to British ships... [and] *we should not recommend the spending of any money in order to obtain information.*" [158]

◀ 'Supposed Fenian submarine torpedo boat in the course of construction at New York' fol.77, Adm 1/6551; Edwards reports political no.47, 2 August 1881, ibid fols.118–119, and political no.49, 5 August 1881, ibid fols. 151–3; Foreign Office to Admiralty 3 August 1881, ibid fol.106; Drummond report secret no.229, 8 August 1881, ibid fol.164; Edwards report political no.53, 1 September 1881, and enclosures, ibid fols.169–71; Sackville–West to Foreign Office 20 October 1883, Adm 1/6693

[156] Booker report 26 October 1883, Adm 1/6693. The effort which British officials put into monitoring Holland's activities may be contrasted with the total indifference alleged by the Admiralty critic Stanley Bonnett in *The price of Admiralty: an indictiment of the Royal Navy 1805–1966* (London 1968) pp.151–3.

[157] Hopkins minute 9 August 1881, 'Suppposed Fenian submarine...' fol.89, Adm 1/6551

[158] Barnaby minute 12 June 1880, ibid fol.7

Between 1860 and the turn of the century most naval powers of any consequence built at least one experimental submarine. Several of these boats have been mentioned above – the French *Le Plongeur* (1859–67), Russia's Alexandrofsky and Drzewiecki submarines (c.1863 and 1879), the *Hunley* and Halstead's *Intelligent Whale*, both constructed in America during the 1860s, and the Spanish *Peral* (c.1886). In addition, Italy launched a submarine in 1890 and Portugal's *Fontes* was completed in 1892. There were unconfirmed but persistent rumours that Germany had built two boats of the Nordenfelt type and tried them in the naval manoeuvres of 1890.

Even setting aside the *materiel* inadequacies which bedevilled all these submarines, the Royal Navy still had three good reasons, and one bad one, for doubting that any would be a real threat. Firstly, diverse as they were in conception and design, not one of the boats had the unqualified support of the naval authorities. Proponents and opponents of submarine construction came and went, and the type was never developed with the consistency needed for long–term success. In addition, many of the submarine's most fervent supporters were junior officers whose views were as easily ignored by their own navies as they were by the British Admiralty. Secondly, it was obvious that the capabilities of the boats produced in this period were grossly exaggerated in propaganda issued by the inventors and by the patriotic enthusaism of the mass media. No trial could be conducted, it seemed, without it being accounted "a complete success". The Royal Navy never took such press coverage particularly seriously, but its very extravagence set the usually mundane deficiencies of the submarines themselves in perspective. Thirdly, the factions that actually promoted underwater warfare did so for reasons that did not necessarily include actual belief in the short–term future of the submarine.

Carl Axel Gemzell has pointed out that naval innovation can result from organisational conflict within a naval hierarchy, and that groups struggling for power and influence often back some new invention. In doing so, they create a rallying point and create an association of interest that helps to give the group an identity [159]. The histories of many early submarine projects fit this model. In France the submarine was the child of

[159] Carl Axel Gemzell, *Organisation, conflict, innovation: a study of German naval strategic planning 1888–1940* (Lund 1973) pp.129–37

the *jeune ecole*, where one of the new school's figureheads was the same Simeon Bourgois who 20 years before had persuaded the French navy to build *Le Plongeur*. In 1888 the United States Navy appropriated $150,000 for the construction of a boat, but President Cleveland lost an election and "with the change in administration, interest in submarine development languished." [160] The Italian submarine *Delfino* was twice in commission, in 1896 and 1901–02, but she was laid up during the intervening period of naval disapproval [161]. In Britain the type was to be associated with the Fisher administration, and one Inspecting Captain of Submarines was warned, "you are closely connected with, a great man if you like, but one whose influence and interference are deeply resented, and who is regarded with great suspicion by the Service in general." [162]

One factor remains to be considered: British arrogance. The Royal Navy had considerably less faith in the ability of its naval rivals to produce submarines than it had in its own capacity to do so.

As we have seen, many foreign submarine projects were the work of comparatively junior naval officers who received little moral or material support from their naval authorities. For a time the people of Spain were sanguine about the prospects of Lieutenant Peral's submarine "which, according to the Spanish papers, is destined to raise Spain at once to the rank of a first–rate naval power." [163] From Cadiz the British Vice–Consul reported that "the vessel has awakened very considerable interest in Naval and Scientific circles in Spain", but he was shrewd enough to wonder "how much of this is owing to the intrinsic merits of the invention, and how much to its being a national production." [164] Sure enough, Spainish enthusiasm for the submarine and its inventor (who was

[160] Frank Cable, *The birth and development of the American submarine* (New York 1924) pp.331–2

[161] Report 'Relative to the Italian submarine boat *Delfino*' 21 July 1902, Adm 1/7618; Vice–Consul Towey, 'Report on submersible torpedo boats of the Italian navy' 8 October 1901, Adm 1/7554; Captain Douglas Gamble, 'Italy: fleet, dockyards &c. 1900', NID no.586, September 1900 p.8, Adm 231/32

[162] Keyes to Hall nd (December 1913), Keyes papers 4/22, Department of manuscripts, British Library

[163] Captain Cecil Domville, 'Spain: fleet, dockyards &c. 1889', NID no.71, 24 April 1889, Adm 231/15/207

[164] Henry Macpherson to Foreign Office 29 December 1888, FO 72/1850

ennobled) drained away when the boat failed to live up to the extravagent expectations of the public [165]. Peral and his Portuguese contemporary Fontes were too junior to persuade their naval authorities to do more than construct a single prototype; Peral "wished the Government to build a larger boat, and on their refusal to do so, he retired." [166]

In his study of innovation in the United States Navy, Vincent Davis observes that the successful innovator is usually a man in the broad middle ranks of the service, and seldom the inventor of the innovation he is promoting. This would suggest that Peral and Fontes (like Lt. John Parker, the American proponent of the machine gun) lacked the experience to understand and utilise the unwritten rules and administrative subtleties of their respective services in support of their proposals. They antangonised their superiors with their brash certainty that they were right and all others were wrong, and failed to assess the likely impact which the success of their proposals would have on established practice [167]. Of course, the civilian inventors who plagued the British Admiralty had even less chance of securing a sympathetic hearing for these same reasons.

Greed and corruption had their own insidious effect on the naval policies of many nations. The Admiralty was sceptical when it learned in 1880 that the Russian Minister for Coast Defence had contracted for 50 of Stefan Drzewiecki's little two–man submarines because it suspected there was an ulterior motive for the order. The Russian arms industry worked on a commission basis, agents being paid a percentage of the total price charged for the vessels ordered through them. Not suprisingly, costs were kept as high as the market would bear, and there were considerable fortunes to be made by those who could obtain large orders for any sort of warship. "The fact of this order being given," wrote the British naval attache, "points more to the anxiety to make money on the part of some official entrusted with the power of contracting for manufacture and material, than to any conviction on his part of the actual success or value of the invention." He was sure that "little will be done by the Russians in

[165] CH Hilton, 'Isaac Peral and his submarine', USNI Proc. 82 (1956) pp.1194–1202

[166] Captain William May, 'Spain: fleet, dockyards &c. 1893', NID no.346, April 1893, Adm 231/22

[167] Vincent Davis, *The problem of innovation: patterns in navy cases* (Denver 1967) pp.43–4, 51–3

actual warfare with an invention so intricate and so dangerous to the principal actors" [168].

The attache was quite right. The Drzewiecki submarines were under powered, under armed and dangerous under water. Most of them ended their inglorious careers as floating supports for pontoons and oil jetties, and the torpedo school HMS *Vernon*, which kept an eye on the submarine construction of Britain's naval rivals, reported that "it has been observed by the Russians themselves that no–one, except in a state of drunkenness, would go into this boat." [169]

So much, then, for national projects. The Royal Navy did take an interest in the underwater activities of its naval rivals, but then officers were sent to report on battleships and submarines and improvements in pigeon lofts with equal despatch; it was enough that a potential enemy considered the subject worthy of attention. The primitive boats that came to the Admiralty's attention were reported on in spite of their deficiencies and not because the Royal Navy expected much from them.

By now it should be possible to draw a few conclusions about British submarine policy in the mid–Victorian period. It was, firstly, rather more coherent than the varied reports of the Admiralty's far–flung representatives might suggest. Although individual responses to the submarine varied from the enthusiastic interest of Captain Nicholson to the dry scepticism of Nathaniel Barnaby, the conservative Chief Constructor, there was no significant change in the tenor of Board minutes on the subject in the period 1856–1885, and the Admiralty never seriously contemplated the construction of a submarine boat in these years. Furthermore, investigation and assessment of the submarine problem was inadequate rather than altogether non–existent. The technological limitations of a boat were of far greater interest to the sceptical British than her intended tactical or strategic role, and the Admiralty's technical assessments were accurate and noticeably harder–headed than those of most civilian enthusiasts for submarine warfare.

The Royal Navy kept a watch on the doings of its maritime rivals, but

[168] Captain Ernest Rice, naval attache's report no.11, 27 July 1880, Adm 1/6551; Jacob Kipp, 'The Russian Navy and private enterprise: a peculiar MIC' pp.89–90, in Benjamin Cooling (ed), *War, business and world military–industrial complexes* (Port Washington, New York 1981)

[169] HMS *Vernon* annual report 1885 p.61, Adm 189/5

was not interested in their submarine projects *per se*. It was dismissive of the inventions that were submitted to it, and steadily refused to purchase either completed vessels or plans. Nor did it devote energy to the development of anti–submarine weapons. This was sensible enough, in that there was little point in erecting a fanciful body of theory on so slim a *materiel* base. But by making the comfortable assumption that the weapon was imperfect and likely to remain so for the forseeable future, the Admiralty ignored the fact that a workable submarine might force a reassessment of British naval strategy.

This was a failure of some consequence. The problem was certainly not lack of information – the Admiralty was conspicuously well–informed [170]. It was, rather, primarily administrative. The RN suffered from organisational inadequacy, a sort of intellectual arrogance, and a peculiar strategic short–sightedness.

The Victorian Navy was rarely able to process systematically the diversity of information which it received. No Admiralty department existed to determine strategy and tactics. There was no naval staff, no intelligence department existed before 1882, and the torpedo school HMS *Vernon* was over–worked and understaffed [see section 7.1]. The Naval Lords had little time to devote to such minor issues as the submarine, and the only Admiralty officer with his own staff was the Surveyor (known as the Controller after 1860). For this reason, the mid–nineteenth century Royal Navy was better at assessing technology than tactics.

The Controller's department was not without its faults. The Navy's 'wait and see' policy was a safe one only if it was possible to produce a workable submarine design quickly, but the department had no experience of such work and no contingency plans existed. The men of the Controller's staff were fully confident that with the accumulated expertise of British naval architecture behind them, they could out–design and out–build any other navy: "There would be but little difficulty in designing a submarine boat in every way superior to the one under consideration," wrote Captain Arthur of the *Fenian Ram* [171], and Sir William White,

[170] For example, the RN on more than one occasion secured copies of supposedly secret Russian submarine plans. Cf. Wellesley report 22 January 1873, Adm 1/6281; G Stanley (Consul–General, Odessa) report no.3 political 29 January 1879, FO 65/1054

[171] Captain William Arthur, naval attache's report no.90 2 August 1881, FO 115/673 fols. 209–10

one of the greatest of all Directors of Naval Construction, asserted that "there was no difficulty in undertaking here the design or construction of submarines had it been considered desirable to do so... but it was decided to await developments elsewhere before making a start." [172] In retrospect it is apparent that neither White nor Arthur fully appreciated the special problems of designing a submarine from scratch. The Controller's department did not, in fact, have the necessary expertise to produce a successful submarine boat at short notice. When the Royal Navy decided to build its own craft in 1900, it had to adopt the tried and tested designs of John Holland.

Had Holland's plans not been available, Britain would have found herself at a severe disadvantage. She was then ten or fifteen years behind her French and American rivals, and it would not have been easy to catch up. The RN could doubtless have produced a design of sorts, but – inevitably – would have entered the Great War with a far less efficient submarine than it actually possessed in 1914 [173]. This deficiency would have seriously impaired Britain's ability to blockade the German fleet and jeopardised her anti–submarine capability. The turn of the century was a good time for the Navy to order a foreign submarine; it was also its last real chance to do so.

Finally – and perhaps most importantly – the Admiralty failed to think through the strategic assumptions that it did make. The Royal Navy discarded the torpedo boat because it had no place in a fleet action. In doing so, it fell into the trap of assuming that a weapon it thought useless would pose no threat in the hands of an enemy. Britain was as blind to the danger of the submarine. It was evident that no nineteenth century boat was fit for service on the high seas; low speed, low freeboard and low endurance all suggested that the type was best suited for coastal and harbour defence, and as such it was of little interest to the Royal Navy.

Nathanial Barnaby dismissed the submarine because it was useless as an

[172] Sir William White, cited in Murray Sueter, *Submarine boats, mines and torpedoes* (Portsmouth 1907) pp.137–8

[173] The Austro–Hungarian Navy also believed its own naval architects could produce a workable submarine design unaided, but the plans drawn up by the Naval Technical Committee in 1904 were inadequate and the KuK Kriegsmarine was forced to order its first boats from Lake and Krupp. Erwin Sieche, 'Austro–Hungarian submarines', *Warship* V p.16

offensive weapon [174]. Ten years later the Senior Naval Lord, Sir Astley Cooper Key, implicitly rejected it for the same reason by stressing that British torpedo vessels should "be capable of accompanying the squadron to any distance in any weather... having sufficient speed to overtake an ironclad." [175] But in dismissing the submarine as a weapon unfit for service with a seagoing fleet, the Royal Navy neglected its more limited potential as a scourge of the blockade. In the long run this was to prove a costly mistake.

The Nordenfelt submarines

Once it had been determined that the submarine was a weapon best suited to local defence, it fell naturally into the province of the British army. In the nineteenth century it was the Royal Engineers who were charged with the responsibility for most of Britain's coast defences; the regiment operated searchlights, boom defences and the minefields ('aquatics') at British and Imperial defended ports, and had a maritime arm in the little boats used to lay and maintain its electrically–fired observation mines. The Engineers therefore kept an eye on promising seaborne coast–defence weapons. Towards the end of the century the regiment expended a considerable amount of time and money developing the wire–guided, shore–launched torpedo invented by Louis Brennan, a weapon the Royal Navy had rejected. But a dozen years earlier the Engineers had recommended the purchase of an altogether more dramatic innovation: the Nordenfelt submarine.

The British delegation sent to Sweden in September 1885 to witness the trials of this peculiar vessel comprised three Royal Engineers and only one naval officer, Captain Thomas Jackson. The senior army representative was Lieutenant General Sir Andrew Clarke, the Inspector General of Fortifications, a man best remembered for his governorship of the Straits Settlement in the 1870s. He was assisted by Major General Hardinge Steward, a leading mining expert, and by Colonel George Clarke, who as Lord Sydenham of Combe later served as Secretary to the Committee of

[174] Barnaby minute 12 March 1873, Adm 1/6281

[175] Cited in Philip Colomb, *Memoirs of Sir Astley Cooper Key* (London 1898) p.447

Imperial Defence.

Nordenfelt's first submarine was a 60–ton, 64 foot steam–powered craft with a crew of 3, allegedly capable of making 9 knots on the surface and 4 submerged. On the first day of her trials the boat was exercised on the surface, dipping underwater occasionally but not proceeding submerged for any length of time. On the second, she steamed ten miles out to sea and returned, and on the third at last commenced her diving trials. The party embarked on Nordenfelt's yacht saw the boat submerge for periods of up to four and a half minutes. At best she steamed 300 yards underwater [176].

A distinguished array of notables had been gathered to witness the submarine's trials. Naval officers from Britain, the major European powers, Brazil, Japan, Turkey and Mexico were present, as were the Prince and Princess of Wales, the Empress of Russia and the King and Queen of Denmark. Never before had such a glittering assembly shown an interest in submarine boats. Yet the *Nordenfelt I* was not an especially impressive craft. Many of the submarine's faults, in particular her longitudinal instability when submerged, were hidden from those who had travelled to Sweden. She fired no torpedo, took 20 minutes to dive, displayed little in the way of endurance, and moved about at low speed. Her most attractive feature was a long, low silhouette which, it was agreed, would make her a difficult target for even a quick–firing gun, and she seemed to have more potential as an awash–boat than as a true submarine.

Two more Nordenfelt submarines, built in British yards at Chertsey and Barrow, were purchased by the Turks in 1886 – reportedly on the initiative of the Sultan, rather than the navy. They too rarely ventured under water, and the British naval attache noted the Ottomans had little faith in the boats and "the general opinion of naval officers is much opposed to them." [177] A fourth Nordenfelt, built in the yards of the Naval Construction Company at Barrow, had an even shorter career. She caused a minor sensation by appearing at the naval review held at Spithead to mark Queen Victoria's diamond jubilee, then sailed for Russia, becoming a constructive total loss on the coast of Jutland during her passage. The

[176] *The Times* 9 October 1885 p.13 col.a

[177] Kane report 'Turkish fleet and dockyards 1886', Adm 231/10

Tsarist government refused Nordenfelt's claims for compensation and denied it had ever intended to purchase the boat [178].

Thorsten Nordenfelt was a businessman, not an inventor. His submarines were designed by George Garrett, and the machine gun that bore the Swede's name was the invention of a compatriot, Heldge Palmcrantz. Nordenfelt's contribution to both projects was money and a shrewd marketing expertise. He built a reputation and an extensive network of contacts on the success of his machine gun, and it was his name that attracted royalty and a host of naval attaches to watch the trials of *Nordenfelt I*. A Nordenfelt invention commanded more respect from the world's press and naval authorities than did that of an unknown.

Suitably impressed by the fairly modest trials they had witnessed in Sweden, Steward forwarded a favourable report on the *Nordenfelt I* to the War Office. He observed that "almost all the officers were very much impressed by it," and was "perfectly certain that foreign war vessels would not lay off a port... if they knew there was a submarine vessel there which could come out without being seen. I certainly think that £10,000 would be very well spent in providing a vessel of this class." [179] But Sir Andrew Clarke outdid even Steward in his enthusiasm, suggesting in April 1885 – five months before he inspected the submarine for himself – that £20,000 be appropriated for the purchase of one or two Nordenfelt boats. Nothing came of this request, but to put Clarke's remarkable suggestion in context, it may be observed that the sum in question was equal to the whole estimate for submarine mines, stores and associated buildings for the defence of British merchantile ports in 1885 [180].

The widespread publicity which attended the Landskrona trials brought the submarine to sudden prominence. The British observer Sir George Clarke understood their true significance when he noted that

> "these first public trials of a submarine boat will... undoubtedly produce results far beyond a mere criticism of the existing craft. Many

[178] Murphy op.cit. pp.152–84; *The Times* 24 September 1888 p.9 col.f

[179] Steward at the RUSI 5 February 1886, RUSI Jo. XXX (1886) pp.168–9; 'Nordenfelt's submarine boat' 1 October 1885, digest cut 11a, Adm 12/1138

[180] RH Vetch (ed), *The life of Lieutenant-General Sir Andrew Clarke* (London 1905) p.248; Clarke memo 'Defence of the maritime ports of the United Kingdom' 31 December 1884, War Office papers WO 33/43, Public Records Office

shrewd heads have been set thinking, and the great possibilities of this form of attack have been brought home with a force which no mere description, however graphic, could have excited. It is one thing to read of vaguely described exploits in the American war, or indefinite rumours of Russian experiments. It is quite another matter to be brought face to face with a boat which disappears before one's eyes to reappear in an unexpected position... It may be taken as certain that the perfection of this most dangerous weapon of attack is only a matter of time and brains." [181]

Nordenfelt's energetic promotion of the submarine thus had its effect. Although the Admiralty continued to display little enthusiasm for the weapon, semi–official service opinion (as expressed at the RUSI) was guardedly favourable in the mid–1880s, and the civilian press was often positively enthusiastic. Samuel Long, who chaired the Torpedo Discharge Committee and captained HMS *Vernon*, suggested in 1886 that a committee be formed to assess the recent development of the submarine boat [182], and the appearance of the *Nordenfelt IV* at the Jubilee review off Spithead caused the level–headed specialist journal *The Engineer* to remark that "in the Nordenfelt we have all the elements of a system of attack and defence which will certainly put blockades to an end... We may – we hope we shall – have quite a little fleet of Nordenfelts when Christmas comes around again." [183]

For all its scepticism, the Royal Navy sent representatives to report on both the *Nordenfelt IV* and a privately–built British submarine, the *Nautilus*, in 1886. At least three senior officers attended the latter's trials at Tilbury on 20 December 1886, and two of them – Charles Beresford, the Junior Naval Lord, and Sir William White, the Director of Naval Construction – were on board when the electrically–powered boat made a practice dive and instantly became stuck in the glutenous mud at the bottom of the deep–water dock. The captain, who had a heart condition, collapsed, and for an anxious quarter of an hour the two Admiralty officials

[181] Anon. report in *The Times* 9 October 1885 p.13 col.a. For authorship, see Lord Sydenham, 'The "weapon of the weak"', *Naval Review* 1933 p.48

[182] 'Submarine boat *Nautilus*' 10 December 1886, digest cut 11a, Adm 12/1154

[183] *The Engineer* 23 December 1887 p.519

were able to consider the merits and demerits of submarine warfare while a series of increasingly desperate measures were adopted in an effort to free the vessel. Eventually one of the two (for both claimed the credit) suggested that passengers and crew should rush in a body from one side of the submarine to the other. The boat began to roll, and this induced the mud to release its grip; the *Nautilus* came to the surface and its relieved occupants dragged the submarine's engineer out of their way and scrambled ashore [184]. It was probably no coincidence that both White and Beresford subsequently displayed dislike of the submarine [185].

Despite this setback, the Royal Navy went ahead with an assessment of the *Nordenfelt IV*, and rumours that the Russian government was planning to acquire the submarine may well have influenced this decision. HR Champness, a second class Naval Constructor from Portsmouth, was sent to Barrow to report on the boat's construction [186], and when the submarine arrived at Spithead in May 1887 her trials were witnessed by Captain Arthur Wilson, the Assistant Director of Torpedoes. Also present were Hardinge Steward and General Nicholson, Clarke's successor as IGF; Captains Long of the *Vernon* and Domville of the *Excellent*; and the naval CinC at Portsmouth, Admiral Willes. Wilson at least was not impressed by the *Nordenfelt IV*, submitting a report which suggested that "the vessel would prove of little value in time of war." [187]

In the week before Christmas another party travelled to Southampton Water to witness further trials. It included half a dozen naval attaches and naval men (one of them, Lieutenant WH Jaques of the USN, a future chairman of the Holland company) and William White, the DNC. By a peculiar chance, White's trip to see the *Nordenfelt IV* came exactly one year after his unfortunate experience at Tilbury [188], but he was no more

[184] The *Nautilus* was an electrically–powered submarine designed and built by Messrs Campbell and Ash. See *The Times* 21 December 1886 p.11 col.f; Frederick Manning, *The life of Sir William White* (London 1923) pp.222–3; Geoffrey Bennett, *Charlie B.: the life of Admiral Lord Charles Beresford* (London 1968) p.140. The third officer referred to was Captain Eardley–Wilmot of the DNO's office; see Sydney Eardley–Wilmot, *The British navy, past and present* (London 1904) pp.56–8

[185] Reginald Bacon, *From 1900 onward* (London 1940) p.53; White at the RUSI, RUSI Jo XLVIII (1904) p.308

[186] 'Submarine boat: Mr Nordenfelt's plans' 15 November 1886, digest cut 11a, Adm 12/1154

[187] '*No.IV* trials' 16 + 30 May 1887, digest cut 11a, Adm 12/1170; Murphy op.cit. pp.161–2

[188] *The Times* 21 December 1887 p.6 col.1

impressed by the Nordenfelt boat than he had been by the *Nautilus*. Professional appraisal of two significant projects therefore confirmed the Admiralty's 1886 decision – reached, it must be said, in advance – to reject Captain Long's proposal on the grounds that "the development of submarine boats has not reached a stage to render it necessary." [189]

French submarine development

After abandoning *Le Plongeur*, France lost interest in submarine development for almost 20 years. From the early 1880s, however, work was recommenced by a number of designers working in a private capacity. A Lyons engineer named Claude Goubet completed the plans for the first of two submarines in 1885, and early in the same year the highly–distinguished naval architect Dupuy de Lome began to work on a more ambitious scheme. This timing suggests that the revival of French government interest was fuelled in part by the publicity given to Nordenfelt and the Swedish trials.

De Lome was, however, a notable innovator in his own right. He had designed *Le Napoleon*, the ground–breaking steam battleship, and *Gloire*, the first modern ironclad ship of the line; in the late 1860s he had interested himself in the design and construction of airships. But the great man made scant headway with the problems of submarine navigation before dying early in 1885, having done little to flesh out his novel (if impracticable) conception of a troop–transporting submarine which might expedite an invasion of Britain [190]. His ideas were taken up by a protege, the naval architect Gustave Zede, who made a submission to the Minister of Marine in March 1885. It was coldly received, but Zede's luck changed in January 1886 when a *jeune ecole* administration led by Admiral Theophile Aube took control of France's naval affairs [191].

Aube, a noted theorist, encouraged the development of all manner of

[189] 'Submarine boat *Nautilus*' 10 December 1886, digest cut 11a, Adm 12/1154

[190] Le Masson op.cit. pp.41–2

[191] Ibid pp.42–3

torpedo craft, and within a month of taking office had in principle agreed to finance a French submarine programme. Zede's project was approved in March 1887, and a small electric–powered submarine, the *Gymnote*, was launched eighteen months later. She was unarmed, spent most of her long career as a trial vessel for the French navy, and was not formally commissioned until 1908. Enough was learned, however, for a second submarine to be laid down in 1893 and named *Gustave Zede* after the pioneer designer, who was mortally wounded in 1891 while experimenting with torpedoes propelled by an explosive powder. At 261/270 tonnes, the *Zede* was considerably larger than her predecessor, which displaced no more than 30/31 tonnes, and after fitting out she embarked on a lengthy and frustrating series of trials.

The French did not, therefore, possess a militarily useful submarine until the *Zede* was formally commissioned in 1898, and her immediate successors were only slightly more formidable. By the end of the century the *Marine Francaise* had built an electrically–powered improved *Zede*, the *Morse*, and a longer–range, dual–propulsion submarine named *Narval*. The former was laid down in 1897, the latter a year later.

Morse was designed to incorporate the lessons of the *Gustave Zede*'s lengthy trials. Realising that the *Zede* had been, perhaps, too ambitious an experiment, the French made *Morse* rather smaller (she displaced 143/149 tons), gave her a small conning tower, and equipped her with a single internal tube. But like her predecessor, the new submarine was electrically–powered and had to return to port at regular intervals to charge her batteries at a shore station. The *Narval*, on the other hand, was the winner of a competition organised by the then Minister of Marine, Lockroy, to find a boat capable of steaming 100 miles on the surface and 10 submerged. She was a double–hulled submersible capable of 10/5 knots and armed with four torpedoes in drop collars.

The *Narval*'s most remarkable feature was a 42% reserve of positive buoyancy, which made her far more seaworthy than her predecessors. "All French submarine boats before *Narval* are driven entirely by electricity stored in accumulators...", noted a British intelligence report. "The limited speed renders attacks on other than ships at rest the exception while their small radius of action makes it almost impossible for any of these boats,

except the *Narval*, to go in search of an enemy." [192]

The technical problems of submarine navigation occupied the attention of the French navy, and it was slow to develop strategical and tactical doctrines for its underwater craft. Submarines were initially expected to protect the battlefleet by patrolling harbours and the coast. They were not intended for – nor were they capable of – commerce raiding, but beyond this little was decided. The *Gustave Zede*'s armament (which would, of course, partly determine the submarine's usefulness) was still under debate in 1889; in that year the Minister of Marine was reportedly asked to choose between a torpedo–armed boat and a submarine ram, the latter being Zede's preferred choice [193].

Indecision was rooted in the naval factionalism rife in the Third Republic between the Franco–Prussian war and the early 1900s. The French submarine service was very much the child of Admiral Aube and the *jeune ecole* theorists; when the French navy began to evaluate the *Gymnote* in November 1888, Gustave Zede wrote to Aube to assure him that "I have not forgotten that it was you who asked me to draw up the plan of the submarine which has just been tried at Toulon, and you also who... ordered it to be constructed." [194] Frequent changes of administration and disputes between the leading naval schools significantly slowed French submarine development: there were 32 Ministers of Marine between 1871 and 1905, many of them personally opposed to submarine boats. "The delay of about ten years in completing the *Gustave Zede* is due... partly to changes of opinion of the numerous Ministers of Marine on her possible value," wrote the British naval attache in January 1899. This made the Admiralty sceptical of the *Zede*'s true worth: "Of course, for political reasons she was bound to succeed," asserted the DNO, "and they said she did so, but she is not worth much." [195] The French spent little on submarine construction after Aube had been forced out of office in

[192] Admiralty report 'Submarine boats', NID no.577, May 1900 p.51, Adm 231/31

[193] Captain Domville report 'France: Guns and torpedoes 1889', NID no.211, December 1889 pp.13–14, Adm 231/16

[194] Zede to Aube 21 November 1888, quoted in 'Papers on naval subjects 1903' vol.1, April 1903 pp.70–1, Adm 231/37

[195] Captain Jackson, naval attache's report no.14, 22 January 1899, Adm 1/7422; Jeffries to Egerton 27 May 1899, ibid. (Jeffries was DNO, Egerton the Captain of HMS *Vernon*.)

1889; between 1893 and 1899 total expenditure on constuction amounted to no more than £154,000 [196].

The *jeune ecole* and the torpedo boat were out of favour for much of the 1890s, and the fuss made about the new weapon was regarded with deep scepticism by most Frenchmen. "The most curious thing about the appearance of the submarine was not the considerable sensation which it created, but the fact that comparatively little real notice was taken of it," writes Theodore Ropp. "The New School had a good deal of trouble to drum up the enthusiasm that they did, and the submarine was then regarded as just another form of torpedo boat which was being taken up by these gentry, just as they had taken up successively every naval fad for the last 15 years... The vigour with which the New School hailed it was enough to bring it into some discredit." [197]

The Royal Navy had little chance of making an accurate assessment of French submarines through the swirling uncertainties of continual policy changes and the smokescreen thrown up by over–enthusiastic press coverage. The problem was exacerbated by the strict secrecy observed by the French navy, which persisted up to about 1906 [198]. Between 1886 and 1900 the British relied largely upon guesswork and negative evidence: few submarines were being built, they reasoned, so those that existed must be failures [199].

Only the private manufacturer Claude Goubet was happy to supply the Admiralty with information. In 1895 he invited the Royal Navy to send an officer to see a two–man submarine in which the Brazilian government had taken an interest. The Admiralty despatched the naval attache, Captain Lewis Wintz, to Paris and also instructed Captain Henry Tudor to attend the boat's trials – hoping no doubt to glean some insights into the work being undertaken by its principle naval rival. The strong British interest in this small and largely discredited type underlines the RN's determination to

[196] Reports on the French naval estimates in BNA 1893–1900 (see Appendix 3.) See also John Walser, *France's search for a battlefleet: French naval policy 1898–1914* (University of North Carolina (Chapel Hill) PhD 1976) pp.166–7

[197] Ropp op.cit. pp.540–1

[198] 'Reports on foreign naval affairs: France – fleet, dockyards &c. 1906', NID no.804, September 1906 p.11, Adm 231/46

[199] Cf. 'France – fleet, dockyards and coast defences of the South of France', NID no.70, 16 March 1889 p.10, Adm 231/15

find out anything it could about French submarine development, but the Admiralty did not have much to learn from M. Goubet. The inventor had been rebuffed by the French navy in the 1880s and (as Wintz's successor, Captain Henry Jackson, reported) "for some years they have practically ignored him." [200]

The Royal Navy was forced to rely on very inadequate information in assessing French submarine policy, and this – together with the discredit brought on the subject by the *jeune ecole* and the numerous technological shortcomings of even the best French boats – accounts for the Admiralty's unwillingness to take its rival's submarines seriously before 1898. Only the publicity generated by the apparently successful trials of 1898–1901 forced a reconsideration of this position.

[200] '*Le Goubet*' 12 + 13 June 1895, digest cut 11a, Adm 12/1282; 'Capabilities of *Le Goubet*' nd (1896), digest cut 11a, Adm 12/1295; Jackson report 2 April 1898, quoted in HMS *Vernon* annual report 1899 pp.115–16, Adm 189/19.

The submarine was eventually rejected by the Brazilian navy, and in 1899 Goubet presented her to France.

Turnaround

BRITISH SUBMARINE POLICY 1898–1901

Acquiring the desire

Before 1898, the Admiralty positively opposed the adoption of submarine boats. In 1899 John Holland himself, interviewed after a promotional visit to Europe, said that the British were still hostile to the idea of building submarines, and in April 1900 the First Lord stated in the Commons that the type "would seem, so far as the immediate future is concerned, to be essentially a weapon for maritime Powers on the defensive... It seems certain that the reply to this weapon must be looked for in other directions than in building submarine boats ourselves." [1] Yet by December the Royal Navy had hurriedly and covertly ordered no fewer than six submarines. What caused this remarkable turnaround in naval policy?

The simple answer is fear: fear of the growing potential of undersea warfare, fear that the most modern boats were no longer simply harbour defence vessels but could menace warships in the Channel and threaten squadrons maintaining a close blockade. If Britain went to war, the Navy would probably encounter submarines in action. It needed a better understanding of what they could do, how they would attack and how they could be defeated, than mere written reports could provide. The RN needed its own submarine boats.

*

[1] Holland quoted in Marder, ABSP p.360; Goschen statement 6 April 1900, Hansard 4 Ser.LXXXI col.1402

French perseverance was paying off at last: submarines turned in enthusiastically acclaimed performances in the manoeuvres of 1898 and 1901. In January 1898 the *Gustave Zede* succeeded in torpedoing the battleship *Magenta* in an open roadstead while the latter was at anchor. Although the trial was very carefully organised and the battleship made no attempt to avoid the *Zede*'s attack, the result was unexpected and came as a shock to the majority of naval officers – many of whom had doubted that a submarine could even discharge a torpedo whilst submerged without fatally upsetting her trim.

The manoeuvres of 1898 prompted the British ambassador in Paris to warn Whitehall that "belief in the success of the invention is very likely to encourage Frenchmen to regard their naval inferiority to England as by no means so great as it is considered to be in the latter country" [2], and a report by the naval attache, Captain Henry Jackson, concluded, "these submersible vessels have now reached a practical stage in modern warfare and will have to be reckoned with, and met, in future European war. One of the most important results of the trials has been to demonstrate that a vessel of this type... is capable of crossing and recrossing the English Channel from Cherbourg to Portland unaided... This fact is carefully hid from the public by the authorities, though considered the greatest triumph of this new vessel." [3]

However contrived, however dubiously reported the French manoeuvres were, they showcased the underwater craft as something it had never been before – a vessel seemingly capable of carrying out an effective attack on a capital ship. This development was quite unwelcome, and in May 1900 Goschen – who had returned to the Admiralty as First Lord – scribbled against a batch of reports: "I have read the whole of the papers most carefully, they are not pleasant reading for clearly great strides are being made in the submarine boat." [4]

Progress in France and the United States triggered an alarm–bell somewhere in the collective subconscious of the Admiralty. The RN had long promised itself that no foreign rival would be allowed to gain an

[2] Sir Edmund Monson to FO 28 January 1899, Adm 1/7422

[3] Jackson report 22 January 1899, ibid; see also Jackson report 'Alteration in *Vulcan*'s courses' nd (1900), quoted in HMS *Vernon* annual report 1900, Adm 89/20 p.24

[4] Goschen minute nd (May 1900), Adm 1/7462

undisputed lead in the construction of any warship type, for as Admiral Fisher observed, "*we cannot afford any foreign power to possess any type of war vessel superior to our own.*" [5] Having acknowledged the existence of a threat, the Royal Navy needed more precise information than could be had from attache's reports of foreign progress – and, furthermore, popular interest in the underwater exploits of the French led to the topic of submarine warfare being raised in Parliament on several occasions in 1900–01. Frequent criticism of Admiralty inactivity goaded the naval authorities, and parliamentary answers to the effect that underwater warfare was the preserve of weaker powers masked a geniune growing concern.

The authors of early British submarine policy have often been criticised for their unthinking conservatism, but there is no evidence that collective prejudice held back the adoption of the submarine. On the contrary, the Royal Navy exhibited reasonable skill in its handling of the problem at the turn of the century. To have gone into submarine construction earlier – say with a Nordenfelt boat in the mid–1880s – would have been to undertake an eternity of experiment and fine–tuning that was always going to be as irritating as it was costly. Both the United States and France took 15 years to develop practical submarines, and without a wholly disproportionate effort the RN would have required a similar time to produce even a modest harbour defence boat.

A closer examination of the evidence suggests that a sensible policy has been misrepresented. Once the stratagem of discouragement had outlived its usefulness, the Admiralty dropped it and moved on. It did so without debating the morality of submarine warfare, without denouncing the submarine as underhand, and without allowing blind prejudice to influence its actions. In a revealing memorandum, the Permanent Secretary conceded that "it is so evident that we are individually interested in vetoing anything which might tend to reduce our present naval superiority that I fear it would only excite ridicule if we were now to attempt to put down submarines as 'underhand'" [6], and even AK Wilson – supposed author of the immortal opinion that submarines were "underhand, unfair and damned

[5] Fisher to Selborne 19 December 1900, Fisher papers FP56, Churchill College Cambridge

[6] MacGregor minute 19 February 1901, Adm 1/7515

un–English" [7] – belied his reputation as an arch–conservative in a 1901 paper that explicitly predicted the 'piratical' use of submarines in an illegal *guerre de course* [8]. Despite the protests of a minority of naval officers, the Admiralty's determination to possess and develop submarine boats was not in doubt again until 1919 – and then because the weapon had proved itself an all–too–potent threat.

Yet the Royal Navy's decision to build submarines should not be misinterpreted. The weapon was distrusted, and the UK was, as Arnold–Forster pointed out, "more vulnerable to the attack of submarines than any other nation" [9], since its tremendous naval power depended on the possession of an expensive surface fleet that could not, as yet, defend itself against cheap but efficient underwater craft. "We can delay ...[the submarine's]... introduction no longer," conceded the Controller, "but we should still avoid doing anything to assist its improvement in order that our means of trapping and destroying it may develop at a greater rate than the submarine boats themselves." [10] His colleagues concurred. "I think it a wise policy not to use the inventive power of this country to develop and advance submarine warfare," wrote the Parliamentary Secretary, HO Arnold–Forster. "I am averse to doing more than is at present contemplated – in getting these boats we will be keeping pace with foreigners and able to acquire the necessary knowledge of their powers and limitations." [11] The Senior Naval Lord, too, believed that the purchase

[7] Cf. Edwyn Grey, *A damned un–English weapon* (London 1971) pp.12–14; Reginald Bacon, *Life of Lord Fisher of Kilverstone* I, 218; WS Chalmers, *Max Horton and the Western Approaches* (London 1954) p4n. There is no contemporary evidence that Wilson ever uttered these words, though he did – in a paper of January 1901 – advocate treating captured submariners as pirates [Wilson paper 'Submarine boats', 15 January 1901, Adm 1/7515]. However, the context makes it clear that the proposal was intended to act as a deterrent, and it is by no means sure the author found submarines abhorrent himself. Admiral Bradford, his biographer, does not refer to the subject in his *Life of Admiral of the Fleet Arthur Knyvet Wilson* (London 1923). It is instructive to compare this hoary old naval chestnut with the equally common, equally unfounded tales of ammunition heaved overboard to avoid the grime of quarterly firing practice. See NAM Rodger, 'British naval thought and naval policy 1820–1890: Strategic thought in an era of technological change' in Craig Symmonds, ed, *New aspects of naval history: Selected papers presented at the 4th Naval History Symposium, US Naval Academy, 25–26 October 1976* (Annapolis 1981) pp.141–2, 150n

[8] Wilson memo 15 January 1901, Adm 1/7515

[9] Arnold–Forster memo 13 March 1901, ibid. Arnold–Forster was, of course, referring to the vulnerability of the surface fleet and not to a submarine threat to British trade.

[10] Wilson memo 15 January 1901, Adm 1/7515

[11] Arnold–Forster memo 28 January 1901, ibid

of a few submarines was enough for the moment. "In doing this," he wrote, "I think that we have not only adopted the best course that was open to us, but also done all that we can prudently do... While we are bound to follow up the development of the submarine boats and thus have at our disposal whatever advantages they may possess, it is not desirable to plunge too heavily as it must first be in the dark, nor until experience points us in the direction in which we should work." [12]

The Royal Navy did find roles for its submarines, but it is important to stress that the first craft were not acquired to fulfil any strategical function. The Admiralty considered them to be purely experimental [13], intended only for the purpose of instructing the surface fleet in the appearance and capabilities of boats. There was no immediate intention of integrating the type into the British fleet; Walter Kerr worried that the submarine had "a very limited sphere of usefulness", and sounded more than a little vague in agreeing to their employment "for any purpose to which they can be adapted." The case for purchasing craft for trial appeared to him so weak that when requesting extra funds from the Treasury he suggested, "it is desirable to word the letter to give the impression that the sphere of usefulness of these vessels may be very wide if found to be a success." [14]

The wisdom of the Admiralty's decision to investigate underwater warfare at first hand was, however, almost immediately confirmed by the continued successes of French submarines. During the French manoeuvres of July 1901 the *Gustave Zede* was towed at a speed of 8 knots from Toulon to the Corsican port of Ajaccio, where she successfully torpedoed the battleship *Charles Martel* while the Minister of Marine, who was on board, was eating his dinner. Towards the end of the manoeuvre period the exploit was repeated when the pre–Dreadnought *Bouvet* was struck by a dummy torpedo as she approached her anchorage [15]. The *Gustave Zede*

[12] Kerr memo 20 January 1901, ibid

[13] Bacon to May 13 May 1901, Adm 1/7462; see also AN Harrison, *Development of HM Submarines from* Holland No.1 *(1900) to* Porpoise *(1930)*, BR 3043 (1979) chapter 3.2. Copy in the library of the National Maritime Museum. Harrison, who was DNC from 1961 to 1966, points out that the first Holland submarine was commissioned without having fired a torpedo. This adds weight to the hypothesis that the Admiralty intended its submarines to operate purely as trial horses for the development of A/S tactics.

[14] Kerr minute 26 October 1900, Adm 1/7515

[15] 'Synopsis of the first portion of French manoeuvres in the Mediterranean' 25 July 1901, Adm 1/7507; Theodore Ropp, *The development of a modern navy: France* ▶

thereby became the first submarine to torpedo a moving ship [16]. Reaction to her feats remained mixed; *The Times* wrote of "an event of singular and, one might even add, of grave suggestiveness... of a character, indeed, which may render these manoeuvres historic" [17], but the British naval attache, Douglas Gamble, penned a report detailing the *Zede*'s many defects, remarking that the submarine was "dangerous to live in, her radius of action is very limited, she is too complicated, a bad manoeuvrer on account of her length, and she could not be used at any distance from port" [18] – a notion one would have thought had been largely disproved by the exercises [19]. Contemporary press coverage [20] made much of the *Zede*'s performance, however, and the popular clamour forced the Admiralty to examine the performance of French submarines with some care.

British submarine policy 1853–1900

The naval authorities never ignored the submarine. Though it has always been implicitly assumed that the Admiralty had no interest in and little understanding of underwater craft before the late 1890s at the earliest, a systematic examination of the public records shows that the submarine was *not* an unknown bugaboo. Two primitive boats were built with British

◀ *1871–1904*, Harvard PhD 1937 p.548. The significance of the *Zede*'s achievement was somewhat lessened by the revelation that Ajaccio was an inviolate port into which, according to the manoeuvre rules, enemy ships could not venture. Marder, ABSP p.357n

[16] 'French submarine boat *Gustave Zede*' 29 January 1901, digest cut 11a, Adm 12/1365

[17] *The Times* 5 July 1901 p.9 col.b

[18] Gamble naval attache's report no.139, 26 September 1901 p.16, Adm 1/7554

[19] The confusion arose because the British were, as usual, short of reliable information on French submarine development. On this occasion the consul at Ajaccio had chosen to absent himself on leave for the whole of the manoeuvre period, appointing in his place – as Admiral Fisher warmly recounted – a local deputy who had an incomplete grasp of English and a quite insubstantial understanding of naval affairs. "Needless to add," Fisher exploded, "that I have not succeeded in obtaining the desired information from Ajaccio... which would enable me to inform Their Lordships how far it was a pre-arranged affair in order to give prominence to and to popularize the submarine boat policy of the French Admiralty." Fisher report 'Serious disadvantage to the public service caused by British consul having been on leave during the French naval manoeuvres off Ajaccio' 16 July 1901, Adm 1/7505. See also Bacon minute to NID report of 11 January 1901, Adm 1/7462.

[20] See citations in Marder, ABSP p.358n

government funds, one in 1814 [see appendix 2] and the other in 1855. The Royal Navy recorded details of more than 320 nineteenth century submarine projects. It made thorough assessments of more than a dozen of the boats that were actually built. Britain had a submarine policy long before the weapon was finally adopted in the period 1900–01.

That policy was broadly consistent between 1856 and 1899. It was based on the naval certainty that Britain need not and should not innovate, but should study the experiments conducted by its maritime rivals and rely on a superior industrial capacity to out–design and out–build them once a new weapon was perfected. Though this was a sensible strategy, it could lead to naval complacency, political and economic inertia and (consequently) to recurrent panics; the scramble to acquire a submarine in 1900 was caused by the belated realisation that the French navy had acquired an appreciable lead in construction, just as the nineteenth century naval scares were sparked by recognition that the British surface fleet was losing ground to its rivals. The Royal Navy is, therefore, open to criticism not for declining to formulate a submarine policy, but for failing to develop the policy it had.

Naval conservatism was more instinctive than institutional. Its apparent prevalence resulted in part from the leisurely pace of the administrative system and from that system's failure to allocate responsibility; equally, it was emphasized by a lack of funds, the necessity of budgetary stringency and the politicians' tendency to judge the Navy on economic as much as military grounds.

It would have been odd if the rapid pace of technological change did not leave some officers bewildered and anxious to cling to ideas that they understood. But the relatively advanced level of much nineteenth century debate sometimes goes un–noticed by those dazzled by Fisher's tales of rigid naval conservatism [21]. In fact the 'conservative's arguments were essentially practical. They doubted, for instance, that steam engines were reliable, that breech–loaders were safe, and that Whitehead torpedoes were accurate; they pointed out that Victorian submariners could not see where they were going when submerged. They were right to voice their disquiet.

For all its supposed conservatism, the Admiralty made adequate technological assessments of the nineteenth century submarine projects that came to its attention, measuring the potential of such boats against a set of

[21] Cf. Fisher, *Memories* (London 1919) and *Records* (London 1919); Mackay, *Fisher of Kilverstone* (Oxford 1973) pp.265, 300

unstated but consistent criteria. To the RN a useful underwater craft would need mechanical power, a useable weapons system, the ability to see where she was going and – most importantly – the seakeeping to steam outside local waters. Boats that did not possess these capabilities were dismissed as inefficient.

The Victorian Royal Navy was not alone in expecting too much of early submarine builders. The specifications laid down by USN for its 1887 open competition were not met by any boat designed before the 1930s. And as Murphy points out [22], Victorian projectors who habitually made the most extravagent claims for their inventions were themselves largely to blame for encouraging naval insistence on outstanding performance.

It must nevertheless be admitted that the RN's strategists failed to recognise the likely significance of peripheral innovations such as the submarine. Although almost equally untried weapons – the breech–loader, the turret, the fish torpedo – were tested because they might be useful to the battlefleet, emphasis on the importance of fleet actions and trade protection generally over–rode interest in the Navy's third great role, coastal defence. It was the Royal Engineers, not the Royal Navy, who drew attention to the value an efficient submarine would have in local waters and, in many naval minds, it was the duty of the Engineers, not the Navy, to concern themselves with harbour defence. This, coupled with over–reliance on purely technical assessement, precluded adequate examination of the likely impact efficient boats might have on naval strategy.

It seems reasonable to conclude, therefore, that it was the RN's poor capacity for strategic planning that gave rise to the most peculiar failing outlined in section 1: the inability of an organisation which had conceded by 1855 (and effectively as early as 1804) that an efficient submarine would one day be produced to recognise prior to the early years of the twentieth century that such boats now existed.

In his important work on military innovation, IB Holley suggests that "the greatest stumbling block to the revision of doctrine... [is]... probably not so much vested interests as the absence of a system for analyzing new weapons and their relation to prevailing concepts of utlizing weapons", and

[22] William Scanlan Murphy, *Father of the Submarine: the life of the Reverend George Garrett Pasha* (London 1987) pp.160–1

hypothesises that "the pace at which weapons develop is determined by the effectiveness of the procedures established to translate ideas into weapons" [23]. The Victorian Navy had no such procedures and no such system. With the exception of the Surveyor and, later, the Director of Naval Intelligence, no Admiralty officer had a staff capable of analysing data and making projections. The RN was therefore generally unable to evaluate the excellent intelligence provided by its network of consuls and naval attaches. Confronted by a rival intent on maintaining security, such as the submarine service of the French Navy, it was unable to make a realistic estimate of the pace of technological change.

Similarly, rejection of the submarine as a suitable vessel for the seagoing Royal Navy was not accompanied by an evaluation that recognised its value, even in a relatively primitive form, as a scourge of the blockade, harbour–infiltrator, panic–monger and coast–defender.

This failing was compounded by another fault, the (perhaps understandable) failure to take civilian inventors and the activities of minor naval powers sufficiently seriously. The RN was more interested in the most obscure doings of the French than it was in the valuable work of John Holland, even after the Irish–American was commissioned to build a submarine for the US Navy [see below]. Had it taken Holland as seriously in the 1890s as it did in the 1880s, when his involvement with O'Donovan Rossa and the Skirmishing Fund made the *Fenian Ram* a direct threat to Britain, the Navy might have realised a little sooner that the submarine was beginning to fulfil its potential.

In the end, though, it mattered little that Britain's first submarines were acquired hastily and with no real conception of their function or their potential. By purchasing boats of a tested American design, the RN rendered the French lead in submarine construction effectively worthless. Though it had worrying defects, therefore, Britain's 'wait and see' policy worked spectacularly well, from the *materiel* point of view, in the case of the submarine. It follows that the Royal Navy's nineteenth century submarine policy was broadly sensible and – essentially – quite correct.

In the twentieth century, however, the strategic problems posed by submarine boats became more complicated and the defects of the British

[23] IB Holley, *Ideas and weapons: Exploitation of the aerial weapon by the United States during World War I; a study in the relationship of technological advance, military doctrine, and the development of weapons* (Hamden, Conn. 1971) pp.15, 19

system more worrying. In particular, the tendency to assess *materiel* without relating its development to strategy caused many naval officers to dismiss the submarine as late as 1914. They did so not because they were utterly ignorant of underwater warfare but because they had seen submarines touted for decades without ever becoming a significant threat.

Acquiring the design

"The matter of submarine boats cannot be ignored and must be taken up by us," minuted Walter Kerr in March 1900. "Our first want is a design." [24] This want is central to the understanding of turn–of–the–century British policy.

There was, in 1900, no hope of securing a French design from which to work, but considerable strides were also being made in the friendlier waters of North America. Interest in submarines, sparked by the Civil War, had never entirely died away in the States, and between 1887 and 1893 the USN held three open competitions for boats designed to meet the Navy's stringent specifications – including the ability to steam at two knots for eight hours under water and for 30 hours at 15 knots on the surface – and examined the designs of, among others, Nordenfelt, Lake, Baker and Holland [25]. Holland's plans were declared superior on each occasion, and in 1893 cash was appropriated for the construction of the steam–powered *Plunger*, a less–than–satisfactory boat which the inventor had designed to meet the USN's unrealistic demand for surface speed. It soon became apparent that *Plunger* would be an abject failure and Holland resorted to desperate measures, financing the construction of another boat built to his own specifications himself. This craft, usually known as the *Holland VI*, was completed in 1899, offered to the USN, and put under trial. She emerged triumphantly, and six boats of a slightly modified type were ordered in August 1900 [26].

[24] Kerr minute 22 May 1900, Adm 1/7462

[25] Frank Cable, *The birth and development of the American submarine* (New York 1924) pp.95–103; Murphy op.cit. p.160

[26] Richard Morris, *John P Holland 1841–1914: inventor of the modern submarine* (Annapolis 1966) pp.79–111

The Holland Company had, by now, metamorphosised into an aggressive, commercial concern anxious to sell boats to all comers. In the last months of the nineteenth century the firm had been taken over by the man who supplied it with electric storage batteries, a German–American patent lawyer named Isaac Rice.

Rice (who was, incidentally, a leading member of the Peace Society) made his name and fortune as a negotiator for America's railroad companies before going into business for himself in 1893 and spending freely in an attempt to monopolise the production of storage batteries in the United States. He saw that submarine construction would create further demand for batteries and complement his existing interests in electric launch manufacture and the mass–production of electric cars [27].

Attracted by his supplier's reputation as a tough negotiator, impressed by his circle of Washington contacts and – like many practical inventors – anxious to return to the workshop, John Holland agreed to transfer his submarine patents to a new firm to be controlled by Rice. Although careful not to offend Holland (whose name was well known and whose potential for securing the Irish vote would prove useful on Capitol Hill), Rice made sure that the inventor's control over the newly–formed Electric Boat in excess of $90 a week and in 1904 he left the EBC to resume – at the age of 63 – his career as an independent submarine designer [28].

Having established the Electric Boat Co., Rice set about promoting Holland submarines. He publicised the private trials of the *Holland VI* and took care to inform interested foreign governments that the designs were available to interested parties. "It must be admitted," wrote the British naval attache, Captain Ottley, late in 1899, "that the leading spirits of the... company are enterprising and wealthy people, who have taken the thing up with the avowed intention of making the boat a success... The Holland Company does not hold itself in any way bound to manufacture solely for the American Govt., nor do I gather that there is any present desire on the part of the authorities to monopolise the invention." Holland's design still had major defects, Ottley thought, but it could soon be

[27] For Rice's background, see Vickers papers VP 632/161 and 632/362, Department of Manuscripts, Cambridge University Library, and RC Trebilcock, *The Vickers brothers: armaments and enterprise 1854–1914* (London 1977) pp.99–101. The Electric Boat Co. is now a division of the General Dynamics Corporation.

[28] Morris op.cit. p.123

perfected by British naval expertise [29].

In 1900 Rice embarked on a promotional trip to the Old World. He did not scruple to make use of his extensive contacts among the multi–national banking houses of New York; the merchant bankers August Belmont & Co. were shareholders in the EBC, as were Rothschild's [30], and before he sailed for Europe in July Rice asked Belmont to provide him with an introduction to Rothschild's London office. "As far as England is concerned, [I] expected to be guided entirely by the advice I might receive from Lord Rothschild," wrote Rice, and he "almost immediately through the kindness of Lord Rothschild began negotiations with the Admiralty." [31] The American must have been surprised and delighted to find such well–prepared and fertile ground for his proposals in a country he had every reason to suppose would rebuff him [32].

Possession of the right 'contacts' was undoubtedly an important plus for any unknown visiting the Admiralty with a business proposition. Prince Albert's name had opened many doors for Wilhelm Bauer, and in 1859 the Chicago lawyer William Delaney used an introduction from Sir William Pakington, a relative of the then First Lord, to interest the Surveyor in Lodner Phillips' submarine. When George Garrett persuaded the Admiralty to examine *Resurgam* it was with the help of Albert Durstan, a naval engineeer attached to Portsmouth dockyard, and Hugh Birley, a well–known Manchester figure and friend of the First Lord and the Secretary of the Admiralty. Now Rice showed that he had a distinct advantage over John Holland, who had visited Great Britian with so little success only two years earlier. The name of Rothschild carried quite enough weight to secure him an immediate interview with George Goschen [33].

Rothschild's influence was significant but should not be exaggerated. He could direct an existing British intention to benefit Rice's own financial interests, but he could not create interest where there was none. Having decided to build its own submarine boats, however, the Royal Navy had

[29] Ottley naval attache's report no.9, 18 December 1899, Adm 1/7471

[30] Rice to E. Naumberg of the EBC 9 January 1907, VP 632/161 fol.91

[31] Rice to A. Trevor Dawson of Messrs Vickers 7 November 1906, ibid fol.76 Rice's letter of introduction from Rothschild (13 July 1900) is in Adm 1/7515

[32] Cable op.cit. pp.332–3

[33] On Bauer, see section 1.2; on Phillips' submarine, see Surveyor to Delaney 30 December 1858, Adm 91/21 fol.742; on Garrett, see Murphy op.cit. pp.51–2, 54–5

little choice but to negotiate with the American patent lawyer; its only alternative was to start designing submarines from scratch [34]. When Rothschild wrote to Goschen asking whether Rice should be provided with a letter of introduction, the First Lord replied in the affirmative [35].

In acquiring the rights to the Holland's invention, the British were buying a quarter–century of experience. Whatever its doubts about the performance of the American craft, whatever its belief in its superior design capability, the Admiralty could not deny that there were compelling reasons for closing the deal. "The purchase of the Holland boats would give substantial advantages in point of assured and immediate success, since we profit by all the years of work and experiment on actual vessels which Mr Holland has performed," noted Sir William White – still, for the moment, the Director of Naval Construction [36]. Lord Selborne, who became First Lord of the Admiralty in 1901, remarked that "the value and importance of this step as enabling us for the first time to commence an investigation of this invention can scarcely be exaggerated." [37]

The decision to order five *Holland*–class submarines was taken by the Board of Admiralty over the protests of White and the Treasury that such a number was excessive and that individually the boats were too expensive [38]. White still believed that Britain did not need submarines, but his rearguard action was to be the last serious attempt to block their introduction. The DNC's ineffectual opposition shows just how difficult it was for any naval hierophant to influence a policy that was largely reactive and dictated by the activities of Britain's naval rivals; there were too many other factors to be considered for the resistance of one officer to be decisive.

Contemporaries were puzzled by the Admiralty's superficially extravagent first order for five submarine boats. The decision was, however, in keeping with the RN's cautious and negative submarine policy. Surviving references

[34] Cf. draft letter to the Treasury 25 October 1900, Adm 1/7515

[35] Rothschild to Goschen 23 July 1900, ibid

[36] White memo 31 November 1900, Adm 1/7516

[37] Selborne memo 15 January 1901, Adm 1/7515

[38] White memo 19 September 1900, ibid; Treasury to Admiralty 9 November 1900, ibid. Wilson originally suggested ordering only one submarine, but by September had decided to request the purchase of five boats. Memos of 3 August 1900, Adm 1/7462, and 17 September 1900, Adm 1/7515

suggest that a multiple order was placed so that a Holland boat could be sent to each of the Home Ports, thereby giving as many ships as possible the opportunity of exercising against a submarine [39]. Altogether more puzzling was a simultaneous order for the first A class submarine, a quite radical reworking of the basic Holland type [see section 3.2]. It seems probable that permission to develop a more advanced sixth boat was given on the grounds that France and the United States were making rapid progress with their own programmes; equally importantly, *A1* was an experimental design intended to test the seaworthiness of a 'large' submarine of the sort necessary to keep the seas around the British coast and provide the Royal Navy with experience of building and operating the more powerful petrol engines needed to power such a craft [40]. The order for *A1* was thus important for several reasons. It reaffirmed the continuity of British policy – for the RN had long insisted that only seagoing torpedo craft were of use to the world's greatest naval power – and marked the beginning of genuine interest in submarines for their own sake. It emphasised the Navy's confidence in its ability to design a submarine, and it demonstrated the energy and resources the Admiralty was prepared to devote to submarine construction.

There remained the choice of a shipyard. Isaac Rice suggested that the first British boat, *Holland 1*, should be built in the United States by EBC sub–contractors, but this proposal was unacceptable to the world's greatest sea–power [41]. The Royal Navy's insistence that its submarines be built in the United Kingdom meant (as Lord Rothschild had doubtless already realised) that the EBC needed a British partner, and if Rice had no strong preference for any particular concern, Rothschild did: he favoured the ambitious combine of Messrs Vickers, Sons & Maxim.

[39] Wilson memo 17 September 1900, ibid

[40] Bacon report 'Type of submarine boat for 1904', 7 November 1903, Adm 138/180B section 31, National Maritime Museum

[41] 'Notes of an interview between Mr Rice, the Controller and the Director of Naval Construction' 16 October 1900, Adm 1/7515

Materiél

SUBMARINE CONSTRUCTION AND DEVELOPMENT 1900–1914

Submarines and the British arms industry

In 1900 the Royal Navy was supplied by the world's finest naval armaments industry. Private companies, supplemented by four Royal Dockyards, met the needs of the huge Imperial market and exported successfully to every corner of the world against increasingly stiff competition. The arms firms remained efficient, thanks to investment in new technology, while British manufacturing industry declined in relative importance and other nations industrialised. Many of their products were world–beaters. At the turn of the century the capital ship was the most complex machine ever built.

Yet building warships has always been a dangerous business. Even in 1900 demand was unpredictable; the profits of an arms race often had to sustain the industry through long, lean years of retrenchment. Over–rapid expansion of capacity during a crisis could prove disastrous, and the domestic market was dominated by a monopsonist – the state. There were no private customers for warships.

Arms firms sought protection in vertical integration and diversification into consumer goods. Vickers itself was the first company to boast it could build a battleship complete from the keel up. All the great names – Thames Ironworks, Browns, Palmers, BSA and Scotts, Vickers and Armstrongs – could be found on a list of the 100 largest British companies; five, including Vickers, were in the top 20 [1].

[1] Much of the background material concerning the British arms industry in the pre–war period is drawn from notes taken during a series of lectures on 'Government, industry and ▶

These large, thoroughly independent, companies could design and build warships as good as or better than those produced by the Director of Naval Construction. Vickers, the youngest of the great arms firms, was well suited to the task of developing the submarine, and worked enthusiastically after it discovered that, ton for ton, underwater craft were more profitable than any other class of warship. (Profits of over 100% were not unknown.) With the help of a group of talented Inspecting Captains – Reginald Bacon, Edgar Lees and Sydney Hall – the company produced submarines that were among the best in the world. But caution and the desire for continuity dictated that each class from the Hollands to the E boats was designed primarily as an advance on its predecessor. None was built to meet the specific strategic and tactical needs of the Royal Navy [see also sections 4.2 and 6.1].

The first major change in construction policy came in 1910 with the appointment of Roger Keyes to the submarine service. Keyes, who thought Holland's original design had been stretched to its limit, began to order submarines from foreign manufacturers. He laid down a pair of experimental boats twice the size of any previous submarine and installed steam engines in one of them. The continuity of Bacon, Lees and Hall was broken. Keyes ended the *de facto* monopoly of construction enjoyed by Messrs Vickers and consciously reversed many of his predecessors' policies.

Vickers and the submarine

Late in the nineteenth century the great Armstrongs combine dominated the British arms industry from its factories and shipyards along the Tyne, intimidating a succession of governments. Vickers (then a Sheffield steel–making company) was recruited to the arms industry in 1888 with the promise of government work in order to weaken the Elswick concern's increasingly powerful bargaining position.

The company was then controlled by two third–generation Vickerses. Albert's entrepreneurial gifts were complemented by a genius for the

◀ the arms race: Great Britain 1890–1914' given at Cambridge University by Mr RC Trebilcock of Pembroke College during the academic year 1983–4. Mr Trebilcock plans to incorporate the material in a forthcoming work, *The Perpetual crisis: an economic history of the armaments industry 1890–1914*.

selection of top–quality managers, while the company Chairman, 'Colonel Tom' (a militia officer), was an expert steelmaker. The Vickers brothers were ably assisted by a gifted Board of Directors led from 1896 by Lieutenant A. Trevor Dawson, a naval gunnery specialist. By 1900, its order books filled by the Boer War, Vickers was almost as powerful as Armstrongs.

When Isaac Rice approached the company, it had only recently diversified into shipbuilding by purchasing the Naval Construction Company at Barrow–in–Furness (1897). But though the Barrow yard had built both *Nordenfelt II* and *Nordenfelt IV*, and Vickers had also absorbed the Maxim–Nordenfelt concern itself, the Vickers brothers had shown no previous interest in the submarine; indeed, both men doubted that underwater craft were practicable [2]. According to Charles Craven, a young submariner who became Managing Director of Vickers–Armstrong in the 1920s, Rice "was informed... that there was no possibility, in their opinion, of the British Navy building submarines." It was left to the American to surprise his hosts with the news that the Admiralty had already ordered five submarines, provided they could be built in British yards [3].

Acting on the advice of one of their principal shareholders, the Vickers brothers decided to investigate the possibilities of a deal. Their advisor was none other than Lord Rothschild, who had invested heavily in the Maxim gun company and taken up a large number of Vickers shares when the two firms merged in 1897 to become Messrs Vickers, Sons & Maxim. (In addition Albert, especially, was on close terms with Cassel and many of the banking families among whom Rice and Rothschild moved easily.) Rothschild's protege Sigmund Loewe – who had recently joined Vickers from a German arms firm – had already met Rice on a trip to the United States in 1898 [4]. He assumed a central role in the early relationship between Vickers and Electric Boat [5], and was allocated 600 of

[2] RC Trebilcock, *The Vickers brothers: armaments and enterprise 1854–1914* (London 1977) p.105

[3] 'Statement by Sir Charles Craven on the relations between the Electric Boat Co. and Vickers Ltd', 9 January 1936, to the Royal Commission on the Private Manufacture of and Trading in Arms, Parliamentary papers Cd. 5292, Q.2300, p.324

[4] JD Scott, *Vickers: A History* (London 1960) p.63; Trebilcock op.cit. p.100

[5] Cf. Loewe signature to Vickers/EBC agreement 27 October 1900, Vickers papers, Cambridge University Library VP 57/60/1; Loewe to H.Atkinson 10 January 1901, VP 1003 fol.1; Loewe to Societe Anon. des Forges et Chantiers, same date, ibid fol.2; GA Grindle to Loewe 27 March 1901, ibid fol.59; Rice to Loewe 29 April 1902, VP 632/161 fol.12

the 4,600 preferred shares in the EBC when they were issued [6]. "There is little doubt," observes JD Scott, the British firm's official historian, "that Lord Rothschild intended from the beginning that the negotiations should result in an agreement between Electric Boat and Vickers." [7]

Though Rothschild's motives for arranging a marriage between Vickers and the EBC were financial, Vickers' precise reasons for accepting the contract were never explicitly stated. Although (remarkably) it was obvious there would be profit in even the earliest boats, repeat orders were far from guaranteed and it would have taken remarkable vision to have seen a formidable weapon in the tiny Holland class. But the prospect of building submarines was not intrinsically unattractive. Vickers avoided the considerable expense of research and development by purchasing EBC designs, and the manufacture of underwater craft entailed little modification of the shipyard at Barrow. No special plant for submarine construction was laid down before 1912 [8], and there was no increase in demand for any of the components which caused armaments bottlenecks at the turn of the century, notably armour plate, with its technically demanding formulation, and heavy guns – each of which required twelve months of quite literally continuous machining in the boring, rifling and winding processes [9]. In addition, the Boer War had generated little in the way of orders for naval, as opposed to military, equipment, and Vickers' shipyards had spare capacity.

The company's willingness to begin production was therefore logical – and Rice's offer must have become almost irresistible when it became clear that the Admiralty was prepared to concede a virtual monopoly of submarine construction to Barrow. The initial contract (December 1900) promised Vickers "about half" of the Admiralty's orders for submarines, the remainder going to the state–owned Royal Dockyards. But the same contract stipulated that the Barrow firm should receive a £2,500 royalty on every boat built by the Dockyards [10], and this deterred the Navy from

[6] Rice to Albert Vickers 28 June 1904, VP 632/161 fol.45

[7] Scott op.cit. p.63

[8] Cf. Hugh Lyon, 'The Admiralty and private industry' in Bryan Ranft, ed, *Technical change and British naval policy* (London 1977) p.61

[9] Cf. Report of the committee on shipbuilding arrears, Parliamentary papers Cd.1055 (1902)

[10] Draft of Admiralty contract with Vickers 13 December 1900, VP 624/150 fols.14–16

placing orders with state yards before 1908 [see graph 2]. Of the 84 RN boats completed by August 1914, 74 were Vickers–built.

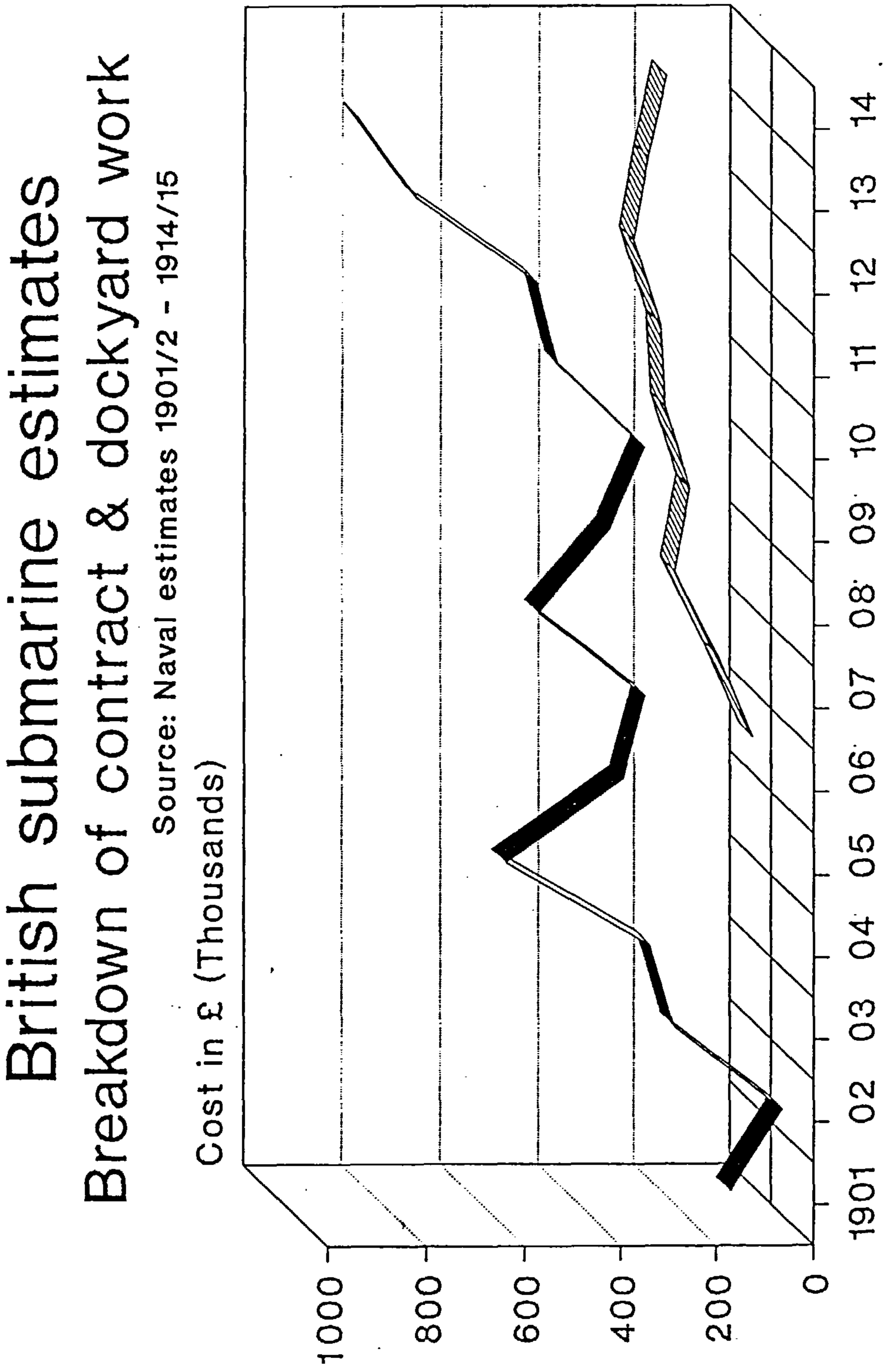
As well as forcing the Admiralty to give preference to the Barrow company, Vickers' contract with the EBC also effectively committed Britain to the Holland submarine and its derivatives. Having agreed to pay the EBC royalties of a half–share of profits on all submarines built at Barrow of whatever type – "a feature that is unique in patent experience", gloated Rice [11] – Vickers had little incentive to invest in alternative technology or acquire the rights to other designs. For its part, the Admiralty gave an assurance that it had no intention of placing orders with other private firms, and undertook not to pass on details of the Vickers/EBC design to any third party. The principal effect of this guarantee was to prevent Admiralty officials from correcting or suggesting improvements in designs submitted by Vickers' rivals; Admiralty 'advice' was, in the eyes of the law, tantamount to communicating details of the Holland design, since the expertise of the Controller's Department had been acquired by studying EBC plans and patents. It was, in short, practically impossible for the Admiralty to involve itself with any British firm other than Vickers without placing itself in breach of contract [12]. The only alternative was to order submarines from a foreign arms firm – and that would fly in the face of the British naval tradition of self–sufficiency.

The Admiralty was, therefore, committed from the first to upholding Vickers' monopoly. This unique concession was a remarkable one [13], and it may seem odd that the naval authorities were prepared to grant it. There were, however, good reasons for the decision. The deal seemed less restrictive than it was to become; it gave the Admiralty administrators less

[11] Rice to E.Naumberg 9 January 1907, VP 632/161 fol.90

[12] Cf. AW Smallwood minute 16 May 1912 and Admiralty solicitor's opinion 14 June 1912, Ships' Covers, National Maritime Museum, Adm 138/246C section 34; also Controller's minute 13 September 1911, Adm 138/404B section 2 and Hall report 19 March 1909, Keyes papers, British Library KP 4/5

[13] The Vickers monopoly was unusual but not entirely unprecedented in the pre–war period. Vickers and Armstrongs exercised a duopoly over heavy gun manufacture. Yarrow and Thornycroft divided up destroyer contracts, and Nobel made covert attempts to corner the UK cordite market by acquiring controlling interests in rival manufacturers. See RC Trebilcock, 'A special relationship: government, rearmament and the cordite firms', *Economic History Review* 1966. It should also be noted that before 1914 all German submarines were built either by the private Germania Yard at Kiel or by the Imperial Dockyard at Danzig. Similarly, all French submarines were built by state dockyards. 'Germany: war vessels 1914', nd (1914), NID No.896, Jellicoe papers Add.Mss. 49003 fols. 113–17; Gary Weir, 'Tirpitz, technology and building U–boats, 1897–1916' in *International History Review* 1984.


British submarine estimates
Breakdown of contract & dockyard work
Source: Naval estimates 1901/2 - 1914/15
Cost in £ (Thousands)
1000
800
600
400
200
0
1901
02
03
04
05
06
07
08
09
10
11
12
13
14
Year
Contract sub. costs
Dockyard sub. costs

to worry about than the complications of arranging an equitable multiple transfer of patents, and naturally pleased Rice – who was unwilling to divulge details of the increasingly valuable Holland designs to more than one firm. The new skills demanded by submarine construction (which have been characterised as the art of cramming a quart into a pint pot) had to be taught to only one group of workmen. And, simply, the tremendous future demand for submarine vessels was not forseen, although a contract drawn up in 1902 obliged Vickers to accept orders of up to 25 boats a year, the first six to be delivered within eight months [14]. The financial cost to the Royal Navy – which had paid out nearly half a million pounds in royalties to the Electric Boat Co. by 1916 [15] – also went uncalculated in 1900.

Finally, Vickers' 1900 deal with the EBC pre–empted any Admiralty attempt to bring other companies into the frame. If it wanted to acquire submarines quickly, the Navy had little option but to reach an agreement with Barrow. "It was recognised," recalled Bacon, "that this close co–operation gave Messrs Vickers a great advantage in manufacture over other firms, but this had to be accepted as part of the peculiar conditions under which we were working." [16]

The Admiralty's chief concern was its determination to keep the submarine programme a secret – at first from the country and then from foreign rivals. Its initial order (18 December 1900) was not announced until May 1901, and *Holland I* was launched without a public ceremony. The secrecy surrounding the RN programme was such that when Lieutenant Forster D. Arnold–Forster (first captain of the first British submarine and nephew of the Parliamentary Secretary to the Admiralty) visited Barrow, he found the Hollands under construction in an obscure part of the yard in a building labelled 'Yacht Shed'. Parts were labelled 'For pontoon No.1' [17]. The Navy did all it could to keep the results of preliminary trials to itself, and as late as 1908 (two years after the French had abandoned their own

[14] The contract appears to have been lost but is quoted in Trebilcock op.cit. p.106. The document appears in full in the US Congressional 'Hearings before the special committee investigating the munitions industry' (Nye comittee), September 1931, volume I p.314, copy in VP 145/1

[15] 'Royalties paid to the Electric Boat Co. in respect of submarines December 1902 – November 1934', 30 November 1934, VP 59/135

[16] Reginald Bacon, *From 1900 onward* (London 1940) p.73

[17] FD Arnold–Forster, *The ways of the navy* (London 1931) p.240

security blanket), dockyard workers at Chatham were sworn to secrecy [18] – all this at a time when the technical details of the latest battleship were freely available in the trade press. So anxious were the naval authorities for discretion that Vickers was forbidden to "build, design, or sell for, or to, any person other than the British government any submarine boat of any kind whatsoever" before 1909 [19], a period subsequently extended by contract renewals. This clause suggests that the Vickers monopoly was in part a *quid pro quo* offered to the firm to compensate for lost export opportunities.

Since the Electric Boat Company was still free to market Holland's designs abroad (the firm had supplied Russia, Japan and the Netherlands with 13 boats by 1907), the Admiralty's policy may seem over–cautious. In fact it merely recognised the degree to which the UK improved the EBC's original designs. While RN submarines retained Holland's ideas in outline, the specifics of design from the A class onwards were essentially British.

The submarine was like a conjuring trick: baffling when seen for the first time but easily copied once the secret was explained. Holland was effectively redundant from the moment his secret came into the possession of the Royal Navy. The inventor's life–work was condensed into nine patents acquired by Vickers from the EBC, but after experimenting with the Holland prototypes the stubbornly independent Bacon was able to write (with some exaggeration) that "none of the Holland patents are of the slightest use except the one which deals with the disposition and shape of the tanks. Further I told the late Controller [May] that I was quite prepared to design a SM boat which would in no way infringe the Holland patents." The real reason for negotiating with the Irishman, as Bacon explained it, was simple: "By accepting the patents, we received, not merely the patents now under review, but the whole of the accumulated experience of the American exporters, which was more valuable than any printed or accepted patents. It was this that the Admiralty really bargained for." [20]

[18] Marder, ABSP p.362; Richard Compton–Hall, *Submarine boats: the beginnings of underwater warfare* (London 1983) p.119; contemporary *Chatham News* quoted in Philip MacDougall, *The Royal Dockyards* (Newton Abbott nd, 1982) p.167

[19] Trebilcock op.cit. p.106

[20] Bacon memo 28 August 1905, Adm 138/246A section 4.

Vickers and the Electric Boat Company

The inequality of Vickers' partnership with the EBC soon began to sour the relationship between the two companies. Vickers' eagerness to acquire Holland's patents had led it to accept an agreement which, as we have seen, anticipated neither the profitability of the UK operation nor the persistant failure of the American firm to make money.

In exchange for the comparatively valueless patents and the invaluable 'jump start' it received, Vickers agreed in 1900 to sign over royalties equivalent to half of its submarine profits. For Rice, the patent–lawyer, the 50–50 split of profits was a triumph, for as he noted, "our licensees... furnish all the working capital and pay us a portion of their profits without any risk to ourselves." [21] The arrangement was modified in 1913 to a 60–40 split in favour of the Barrow firm – an indication of British supremacy in the partnership – but the deal nevertheless cost gross royalties of £1,137,380 on submarines ordered up to the end of the Great War [22].

Soon, however, the Electric Boat Co. ran into trouble. Despite placing an order for six submarines in 1900, the USN was not a good customer for Rice. For one thing it was still a small navy; for another, despite the naval scares of the Spanish–American War, it had no pressing need for minor harbour defence vessels such as Holland submarines. And when, later in the pre–war period, the Americans did acquire maritime ambitions, they preferred to spend their money on building up a blue–water navy [see section 5.3].

Despite his political influence, therefore, Rice had constant trouble with the American politicians who controlled naval spending. Though he affected optimism in a constant stream of reassuring letters to Vickers, it was only thanks to repeated injections of British cash and occasional success with export orders that the EBC survived – building no more than 12 submarines for the USN in the first seven years of the century to the 40 constructed at Barrow for the Royal Navy in the same period. Being almost entirely dependent on a single product, the American firm could not spread

[21] Rice to E. Naumberg 9 January 1907, VP 632/161 fol.91

[22] Nye Committee hearings vol.I pp.313–14. Royalties calculated from 'Royalties payable to the Electric Boat Co. ... 1902–1934' 30 November 1934, VP 59/135

its risks as Vickers did, and it is likely that the EBC would have fared badly if forced to compete with its British partner in a free market. By 1905 the only profits Electric Boat could show were $250,000 from Japanese work, and the firm had already begun to borrow heavily from Vickers in the shape of advances on British construction profits [23]. Two months into 1906 these loans already totalled $340,000 (including interest) [24], and though the Holland type beat its American rival, the Lake submarine, in comparative trials for the US Navy a year later, Rice was shortly reduced to begging Albert Vickers not to sell his 1,600 preference shares – the largest single holding of Electric Boat preferred stock. "It will," the American wrote, "be equivalent to an announcement that you have lost confidence in the company... The result of this may not only produce a panic among our shareholders, but it will also mendaciously be used by our competitor Mr Lake..." [25]

The reaffirmation of British supremacy in the field of naval architecture was thus practically complete long before the First World War. It was very much in keeping with Vickers' repeated triumphs in an increasingly competitive foreign marketplace during the early 1900s – an unusual example of industrial success in a period that saw the UK's relative industrial supremacy severely undermined.

Vickers and the Admiralty, 1900–1911

Submarine construction quickly became vitally important to Vickers. Of the 182 vessels laid down at Barrow between December 1900 and August 1914, 93, or 51%, were underwater craft [26]. Just eight capital ships left the yard in the same period [27].

Net profit on submarine construction amounted to £1,250,000 between 1900 and 1914, the best years being 1906 (£178,000) and 1909 (£237,190)

[23] Rice to Messrs Vickers 6 November 1905, VP 632/161 fol.66

[24] Rice to Albert Vickers 8 November 1909, ibid fol.124

[25] Rice to Albert Vickers 30 January 1907, ibid fol.96

[26] This figure includes three sets of submarine engines for Japan. 'Submarines built by Vickers Armstrong', nd (?1934), VP 740/357

[27] Ibid; Siegfried Breyer, *Battleships and battlecruisers 1905–70* (London 1973); Trebilcock op.cit. pp.107–08

which were otherwise particularly bleak for Barrow. The yard's 'Hull & machinery' account shows that submarine work contributed 56% of profits 1905–14 [28], and provided steady employment for shipyard workers whose jobs were rarely secure [see graph 3].

Individual submarines earned Vickers substantial sums. *Holland No.1* cost a total of £27,052 and was sold for £35,142 – a 30% profit. And though the cost price of subsequent vessels fell dramatically, purchase price remained unchanged; of the six submarines ordered in December 1900, *Holland No.2* made the biggest profit (116.5%), *A1* the smallest (26.5%), and Vickers was enriched to the tune of £89,376 – a 70% overall profit [29] at a time when it was usual for arms firms to accept a small loss on the first vessels of a new class in return for the chance to make money on later orders.

The private shipbuilding industry was able to dominate the submarine trade thanks only to military imperatives that kept the Royal Dockyards relatively inefficient. The dockyards had a very specific role. In peacetime they were geared to building capital ships while maintaining an uneconomically substantial reserve capacity to allow rapid expansion of output in time of war. They were also, traditionally, equipped to provide repair and maintenance facilities for the whole fleet [30]. The dockyards were not expected to build small torpedo craft, and most RN torpedo boats and TBDs were built by private firms. Nor, with all the other demands made upon them, was it realistic for the state yards to produce the highly specialised diesel/electric motors needed by submarines [31].

The Admiralty's policy was therefore to divide warship construction between private and state–owned shipyards. In the 1900s two thirds of all orders were supposed to be allocated to private firms (though in practice orders were divided roughly 60:40), and the private arms industry's control of submarine construction was more than offset by the Royal Dockyards' domination of capital ship building.

The early decision not to build submarines in state shipyards made it

[28] Trebilcock *op.cit. pp.107–08*

[29] VP 739 bundles 5,7,8

[30] Cf. Andrew Lambert, *Battleships in transition: the creation of the steam battlefleet* (London 1984) p.44

[31] Director of Dockyards report 8 December 1911 fols.14–16, Adm 116/1272B

difficult for the Admiralty to check the prices quoted by Vickers. In 1906 the DNC noted that "the cost of these boats is not a matter which can be estimated on ordinary lines in view of the Vickers monopoly" [32], and when Lord Graham observed that "the monopoly allows for fancy prices being charged" [33], he was doing little more than stating the obvious. After Chatham dockyard completed its first submarine in 1908, a comparison of prices charged by Vickers and the state yard revealed a disturbing picture of profiteering by the private arms firm. Vickers routinely passed on the costs of design work, the modification of shipyard equipment and the EBC's royalties to the government, and by 1914 the Controller was driven to protest that "tenders... are so high that it is evident there is a general feeling with the Contractors that we can be squeezed over this very specialised form of construction." [34]

Once granted, however, the monopoly proved difficult to break. Vickers could hardly be faulted for its efficiency before 1909–1910, and though the Admiralty carefully exercised its right to place submarine orders in state yards from 1908, the royalties payable on dockyard work made Chatham submarines no more economic than boats ordered from Barrow. In addition, Vickers soon developed unrivalled expertise. "We cannot do better than co-operate with Messrs Vickers in building the numbers we want," wrote Bacon in 1905. "They have experience which it will take three years for any other Firm or the Dockyards to acquire... The division of work between Vickers and ourselves will provide just sufficient for both. There is no reason to increase the number of builders, in fact there is every reason against it." [35]

Having failed to develop a broad base of submarine contractors, the Admiralty soon found itself caught in what might be termed a 'quality trap'. Vickers' experience enabled the RN to keep pace with the rapid development of the submarine, but evolution was so rapid that the Navy could not risk halting production while a rival arms firm produced a viable

[32] Watts memo 'New designs of submarine boats' nd (July 1906) Adm 138/360A section 22

[33] Graham to Tweedmouth 26 October 1907, Tweedmouth papers case B, 1907/447, Naval Library MOD

[34] Moore memo 18 June 1914, Adm 138/435 section 24

[35] Bacon memo 26 August 1905, Adm 138/246A section 4

design [36]. The same consideration encouraged close co–operation between Vickers and successive Inspecting Captains of Submarines, further cementing relations between the Navy and the arms industry. The first three men appointed ICS – Bacon, Edgar Lees and Sydney Hall – were all technical specialists who felt at home among engineers and arms makers. When Bacon resigned his commission in 1909, it was to take up the position of managing director of the Coventry Ordnance Works, a fledgling arms firm set up by the major shipbuilding concerns of John Brown, Fairfield and Cammell Laird. Lees left the submarine service in 1906 to run the Whitehead torpedo works at Weymouth [37], and in 1910 Hall came close to accepting an offer from the Clydebank shipbuilder Alfred Yarrow, who thought his expertise would help the company to break into the submarine export market [38]. These men knew that, whatever Vickers' motives, the company had worked hard to develop the submarine, and they felt it should be rewarded for its efforts. "They have served us right well in the past," wrote Bacon. "Let us stick to them in the future." [39]

Despite the protection of the monopoly agreement, however, Vickers faced potential or actual competition throughout the pre–war period. When Isaac Rice arrived in Europe, the Southampton torpedo boat specialist Thornycroft was already fleshing out plans for a submarine. Scott, Cammell Laird, Armstrongs and Yarrow all looked seriously at the possibility of building boats for the foreign market before the monopoly agreement was terminated in 1911, and in 1914 Swan Hunter was invited to design a submarine for Greece [40]. An Admiralty document prepared in 1912 listed six private firms that could be invited to tender for British orders: Vickers, Scott, Armstrongs, Beardmore (a Vickers subsidiary), Denny and Thornycroft [41].

[36] Cf Lees report 'Proposed experimental submarine boat...' 16 November 1905 and Lees to Jackson, same date, both Adm 138/360A section 12

[37] The Whitehead Company was then jointly owned by Vickers and Armstrongs. Lees had dinner with Albert Vickers on 11 June 1906; it was probably then that arrangements were discussed. VP 1004 fol.131

[38] Fisher to Hall 11 June 1910, FP 487; Hall to Fisher 15 June 1910, FP 489; Fisher to Hall 18+21+28 June 1910, FP 490, 491, 492

[39] Bacon memo 26 August 1905, Adm 138/246A section 4

[40] 'Australian naval commission' 4 May 1907, digest cut 11a, Adm 12/1440; 'Greece' nd (early 1914), digest cut 11a Adm 12/1525

[41] Untitled memo 1 May 1912, Adm 138/246C section 27

From 1900 to 1913 Vickers did all it could to protect its privileged position – as, later, the company fought to keep the lead the monopoly had given it. Early in 1905 it stopped the EBC granting Holland licences to Armstrongs [42]. In 1912, the Admiralty's decision to place orders with Scotts and Armstrongs [see section 3.2] goaded Vickers into sending letters threatening legal action for patent infringement to both its rivals. Only a vigorous government protest persuaded Vickers to drop the action; the First Lord, Churchill, summoned Trevor Dawson to his office and (in the words of Francis Hopwood, the Additional Civil Lord responsible for construction), "told him very plainly that relations with his firm would become very strained if the firm endeavoured to stop other firms from building submarines for us." Hopwood underlined the Admiralty's determination not to be browbeaten by minuting: "If Vickers, enjoying as they do such a large part of our patronage for submarines, attempted to restrain Armstrongs from building us a new type of boat because of the infringement of some small patented part of a great whole, I should be prepared to see Vickers penalized to the greatest limit consistent with our own interests. I hope the question will not arise... Vickers have too keen an eye for the main chance." [43]

Thornycroft was probably the first of Vickers' rivals to approach the Admiralty with a fully worked out design. In 1901 its interest in torpedo craft took it into partnership with the well known Danish naval architect William Hovgaard, who had become interested in submarines during the 1880s [44]. In 1887 he designed a boat to meet the conditions laid down by the USN in its first open competition, and over the years these plans were modified until in 1900 he offered the submarine to the Danish and then the British and American navies. The RN was sufficiently impressed to pay Hovgaard £100 to come to London and explain the finer details of his plans to the Controller, but the design was eventually rejected because, unlike Holland, the Dane had never experimented with anything larger than

[42] Rice to Albert Vickers 3 January 1905, VP 632/161 fol.56

[43] Hopwood minutes 4 July and 27 June 1912; Moore memo 'Future construction of submarine boats – procedure' 24 June 1912, all Adm 138/246C section 34. Doubtless Vickers relished an ironic reversal of roles; in the 1890s Armstrongs had vigorously resisted its attempt to end the Tynesider's artillery monopoly with a 'campaign of a hundred patents'. Trebilcock op.cit. pp.61–3

[44] Cf. William Hovgaard, *Submarine boats* (London 1887) and 'Proposed designs for surface boats and diving boats' 23 August 1888, TrINA XXIX (1888) pp.351–65

a model [45].

After making an equally fruitless trip to America, Hovgaard decided to enlist the support of a British shipyard, and after making extensive modifications to the plans to incorporate ideas drawn from French designs, Thornycroft submitted the revised Hovgaard submarine to the Admiralty in 1902. It was turned down, principally because the Royal Navy was by now committed to the Holland type [46].

By 1909 delays at the Barrow yard were causing sufficient concern for the Admiralty to warn Vickers – by inviting rival tenders from its competitors – not to take its monopoly for granted. Thornycroft rose to the challenge with a boat developed in co–operation with Holland's great rival Simon Lake, who had first attempted to break into the British market through the agency of the Naval Electric Co. in 1902. Lake tailored the submarine to Admiralty specifications, but though RN officers reported she would make an efficient boat – her advanced double hull design made her eminently habitable, and she possessed better surface buoyancy than Holland's submarines – the design was rejected on the grounds that Lake submarines were uneconomical to run [47].

Armstrongs also saw Lake as the designer most likely to challenge Holland and break the Vickers monopoly. The company knew that more than one British naval officer believed the Lake type was far superior to the RN's Vickers/EBC submarine, and as early 1901 the British naval attache in Washington, Captain Lewis Bayly, had recommended Lake submarines to the Admiralty via a personal communication [48]. In July 1905 Bayly's successor, Dudley de Chair, sent the Admiralty a report recommending the purchase of five Lake boats [49], and when his proposal was rejected, the attache confidentially informed Lake that he "thought

[45] White memo 30 November 1900, Adm 1/7516

[46] Thornycroft to Admiralty nd (late 1902), Adm 138/180B section 25

[47] 'Lake type submarine torpedo boat' 5 April 1902, digest cut 11a, Adm 12/1377; William Jameson, *The most formidable thing: the story of the submarine from its earliest days to the end of World War I* (London 1965) pp.102–04; Watts report August 1911, Adm 138/404B section 1; Hugh Lyon, 'The Admiralty and private industry', in Ranft op.cit. p.57

[48] Bayly to Sturdee 6 December 1901, Adm 1/7529

[49] 'Foreign naval progress and estimates 1904' (USA) NID No.738 (July 1904) p.90, Adm 231/41; 'The *Simon Lake X*' 3 February 1905 in 'Reports on foreign naval affairs 1905' NID No.777 (January 1906) pp.181–3, Adm 231/44; Dudley de Chair, *The sea is strong* (London 1961) pp.122–4

Armstrong's works would make his boat and manage his affairs better than any other firm in England" [50]. Lake agreed. He had already approached Armstrongs with the proposal that they should go into partnership, and de Chair's connections with the Tyneside firm [51] ensured him an interested hearing. So did the proposal itself, for Lake – who was no fool – dwelt on the dubious safety record of the Holland type [52] and stressed the money to be made from submarine construction, assuring Armstrongs that "the profits in submarines in present prices are very satisfactory." [53] Only the American's own excessive financial demands – he eventually over–reached himself by asking for a 33% royalty on selling price, plus a $100,000 advance, rather than the EBC's half share of profits – forced Armstrongs to pull out of the deal [54].

Lake's final attempt to break into the British market was also the last challenge to Vickers before the monopoly was terminated in March 1911. A number of Vickers' main shipbuilding rivals – including Browns, Fairfield and Cammell Laird, the three firms involved in the Coventry Ordnance Works project – formed a syndicate to build a large submarine to the design of Lake and Captain Bacon. The Admiralty examined the plans of the proposed submarine, which would have displaced 810 tons and carried the heavy armament of nine torpedo tubes, but it was passed over in favour of the rival overseas designs championed by Scott and Armstrongs [55].

Both firms had turned to Europe in search of partners with whom to challenge the Vickers monopoly. Scott was granted a licence to build FIAT submarines as early as 1908 [56]. The agreement made the Clydeside

[50] De Chair to d'Eyncourt 2 February 1905, d'Eyncourt papers DEY 6, National Maritime Museum

[51] De Chair to d'Eyncourt 29 October 1905, ibid

[52] Lake to d'Eyncourt 29 December 1905, ibid; 'The present condition of the submarine problem' in 'Papers on naval subjects 1907' NID No.818 (August 1907) p.100, Adm 231/47

[53] Lake to Armstrongs 13 January 1906, DEY 6

[54] Ibid. Lake himself claimed to have abandoned the British market after his more lucrative Russian trade was threatened by the Tsarist authorities. *Submarine: the autobiography of Simon Lake* (New York 1938) pp.209–212

[55] Jameson op.cit. p.104

[56] Scotts Shipbuilding and Engineering Co. Ltd., *250 years of shipbuilding by Scotts at Greenock* (Glasgow 1961) p.90

shipbuilder privy to all the secrets of the successful Laurenti designs and enabled it to tender for submarine orders as soon as Keyes gave Vickers notice the RN would look elsewhere for new boats. It also made Scott the first British arms firm to employ established European expertise to build submarines; FIAT boats saw service with the Italian, American, Portuguese, Swedish and Danish navies.

Armstrongs, meanwhile, struck a less advantageous licensing deal. After abandoning Lake, the Tyneside firm chose to go into partnership with the French Schneider concern, which employed the well known submarine designer Maxime Laubeuf as a naval architect. But, realising that both Scott and Vickers had secured a head start, Armstrongs was rushed into signing a highly restrictive 1912 agreement [57] that did not require the French company to send Armstrongs its plans until after an order had been placed. Not only did this agreement deny the Tynesiders the chance to pick Laubeuf's brains; it also threatened to seriously disadvantage the company, which discovered too late that Keyes's submarine committee planned to force arms firms to submit fully worked out designs with their initial tenders. As the Elswick firm's eminent naval architect Sir Philip Watts observed, "Armstrongs might just as well not have made any agreement with Schneider, as they are probably as capable as Schneider of designing a submarine of unspecified type." [58]

The end of the monopoly, 1911–1914

Try as it might to hide behind the monopoly agreement, Vickers could not prevent rival firms from chipping away at its position. By 1911 Scotts and Thornycroft, and to a lesser extent Armstrongs, could tender for orders, and the Royal Dockyard at Chatham had already produced a number of C class submarines. This made it easier for Keyes to end the monopoly.

Vickers' position had begun to deteriorate by 1909. Demand for surface warships to meet the growing German threat put strain on the company's shipbuilding resources. The latest types of submarine were much bigger and

[57] Correspondence between Schneider and Armstrongs July–September 1912, Armstrong papers, Tyne & Weir archives centre 31/7858–80

[58] Watts to Keyes 16 September 1912, KP 4/23

more complicated than the A, B and C class boats which Barrow had been used to turning out, and the time each submarine spent in shipyard hands increased alarmingly as congestion became a problem [see graph 3]. To make matters worse, Vickers' management had become complacent, and though tremendous profits had been generated by the submarine programme, little had been ploughed back into new plant. Vickers did finance the construction of a tender from its own pocket [59], but the £80,000 spent on modernising the submarine yard in 1912 was the only major investment of its kind – and as the Barrow manager James McKechnie pointed out, "this sum, when compared with the amount of money passed between the Admiralty and ourselves for the construction of submarines... is insignificant." [60]

Delays – especially delays in engine construction, another effective Vickers monopoly [61] – were of the order of 6–7 months by 1911 [62]. Similar hold–ups were not uncommon elsewhere (the French submarine programme especially ran into chronic problems [63]), but they were intolerable to the world's major naval power, and when Keyes presented his case for terminating the monopoly, he was in no doubt that the main factor was "the inability of Vickers to complete the submarines they are building for us within several months of the contract dates... Messrs Vickers' pretentious estimates cannot be accepted. The administration of the firm suffers from a most persistent and apparently incurable optimism." [64]

Keyes had his own reasons for desiring an end to the monopoly [see below and section 4.2], but his report found a receptive audience at the Admiralty. The whole idea of a monopoly was unattractive in the *laissez*

[59] Vickers minute book No.5, resolution of 30 October 1907 to spend £20,000 on a submarine tender, VP 1363 fol.282

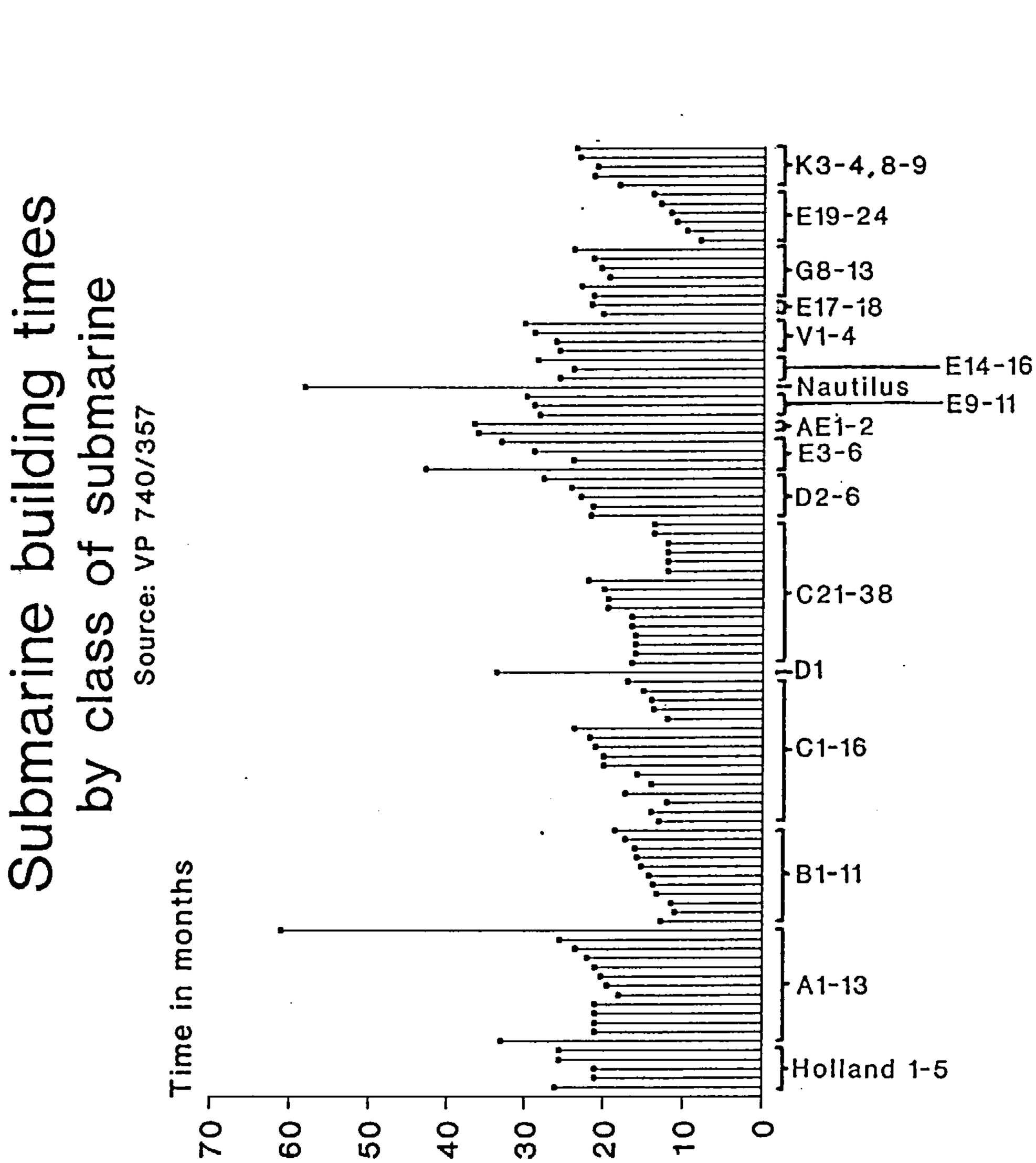
[60] McKechnie to Dawson 6 March 1912, quoted in Trebilcock op.cit. p.107

[61] "It all depends on the engine," wrote Hall in 1911; "it is a pity Vickers are not quicker." Hall to Admiral Briggs 7 February 1911, copy in KP 4/1. For the engine monopoly, see DNC's department report 'Warship construction during the 1914–1918 war' 31 December 1918 p.212, Adm 1/8547/340, and 'Emergency war programme – new construction in destroyers and submarines for', 11 August 1914, Adm 1/8340/256

[62] Director of dockyards report 8 December 1911 fols.14–16, Adm 116/1272B

[63] Cf. 'Foreign naval progress and estimates 1906–1907' (France) NID No.834 (September 1907) p.11, Adm 231/48

[64] Keyes report 'Attempts to bring new forces into the field of production', January 1914 KP 4/11


Submarine building times
by class of submarine
Source: VP 740/357
Time in months
70
60
50
40
30
20
10
0
K3-4, 8-9
E19-24
G8-13
E17-18
V1-4
E14-16
Nautilus
E9-11
AE1-2
E3-6
D2-6
C21-38
D1
C1-16
B1-11
A1-13
Holland 1-5

faire climate of the time. It was unfair [65], and – more significantly – it gave Vickers altogether too much power. In addition, the RN had supported the agreement out of expediency rather than as a deliberate policy, and had never intended it to be permanent. Vickers' monopoly was not clearly established out until 1902 [66], and the Engineer in Chief was anticipating its end as early as January 1904 [67].

Even Bacon, who so often championed the arms firms, believed the Admiralty should take a stronger lead. "I have always strongly urged, though not always successfully, that in the New Agreement Messrs Vickers should be looked on as a manufacturer rather than a patentee," he argued in August 1905, pointing out that if the RN took the initiative in preparing submarine designs, "the Admiralty would be in a position to say, 'if you do not fall in with the terms we consider just, and you cannot satisfy us that you can build on the terms we propose... then we will build for ourselves independent of the Holland patents'." [68]

At this stage there was, as Bacon realised, no need for the Admiralty to resort to litigation or to other private firms. By ordering submarines from Chatham dockyard, the RN introduced an element of threat into its dealings with Vickers and ensured its position as the dominant partner in the relationship. Few boats were actually built on the Medway, but if the Admiralty had taken up its option of placing half of all orders with the Royal Dockyards, Vickers would have been hard hit. The submarine business was already too valuable to Barrow for the company to risk losing it, and in March 1909 the Vickers board decided to cut its losses and concentrate on maintaining its supremacy in the private sector. Alarmed by the Admiralty's ostentatious invitation for tenders from other arms firms, the company therefore meekly conceded its right to claim royalties on Royal Dockyard construction in return for a renewal of the private monopoly to March 1911 [69]. Vickers had realised it had no power to

[65] Cf. the views of the First Lord, Tweedmouth, in a letter to Robertson 10 May 1907, Tweedmouth papers case B 1907/152, Naval Library

[66] Vickers agreement with the Admiralty 17 May 1902, cited in Trebilcock op.cit. p.106

[67] Dunstan minute 15 January 1904, Adm 1/7745

[68] Bacon memo 26 August 1905, Adm 138/246A section 4

[69] Admiralty to Vickers 25 March 1909; Vickers to Admiralty 27 March 1909, ibid section 131

coerce the authorities. So much for arms manufacturers manipulating nations.

Only once the monopoly was finally abolished did Vickers attempt to regain Admiralty favour. But though the company's experience of submarine construction made it certain that contracts would continue to come in – "You had to be given an order!" wrote Keyes [70] – and in absolute terms it won more orders after 1911 than before, its relative supremacy was shattered.

Vickers' first move was to spend money on upgrading facilities at Barrow. After ordering a swift internal enquiry, the company's financial controller, Sir Vincent Caillard, sent yard manager McKechnie a strongly worded letter concluding: "The evidence reveals a very serious state of things which we all think should be put right immediately, and 'immediately' should, in our opinion, be not later than next week." [71] About £37,500 was earmarked for modernising plant and speeding up engine manufacture, the main cause of the delays, in the years 1912–13 [72], and McKechnie was soon able to reassure Commodore Keyes that "we have recently had the whole process of manufacture and supply of submarine boats under review and have, at great expense, considerably improved the facilites for rapid production in connection with this work." [73]

This was not altogether true; in the short term it was very difficult for Vickers to speed work on submarines significantly. The company's shipwrights were still expected to work to painstaking standards of accuracy in very confined spaces. (Chatham had trouble meeting its delivery dates for the same reason in this period [74].) Vickers also had to clear the considerable existing backlog of orders. "The point is that you are several months behind in your 1910/11, 1911/12 and 1912/13 orders," Keyes remonstrated. "In three years you will have delivered eight submarines! You must see that if we continued to trust entirely to you and Chatham we should very soon be left hopelessly behind Germany... I expect you think

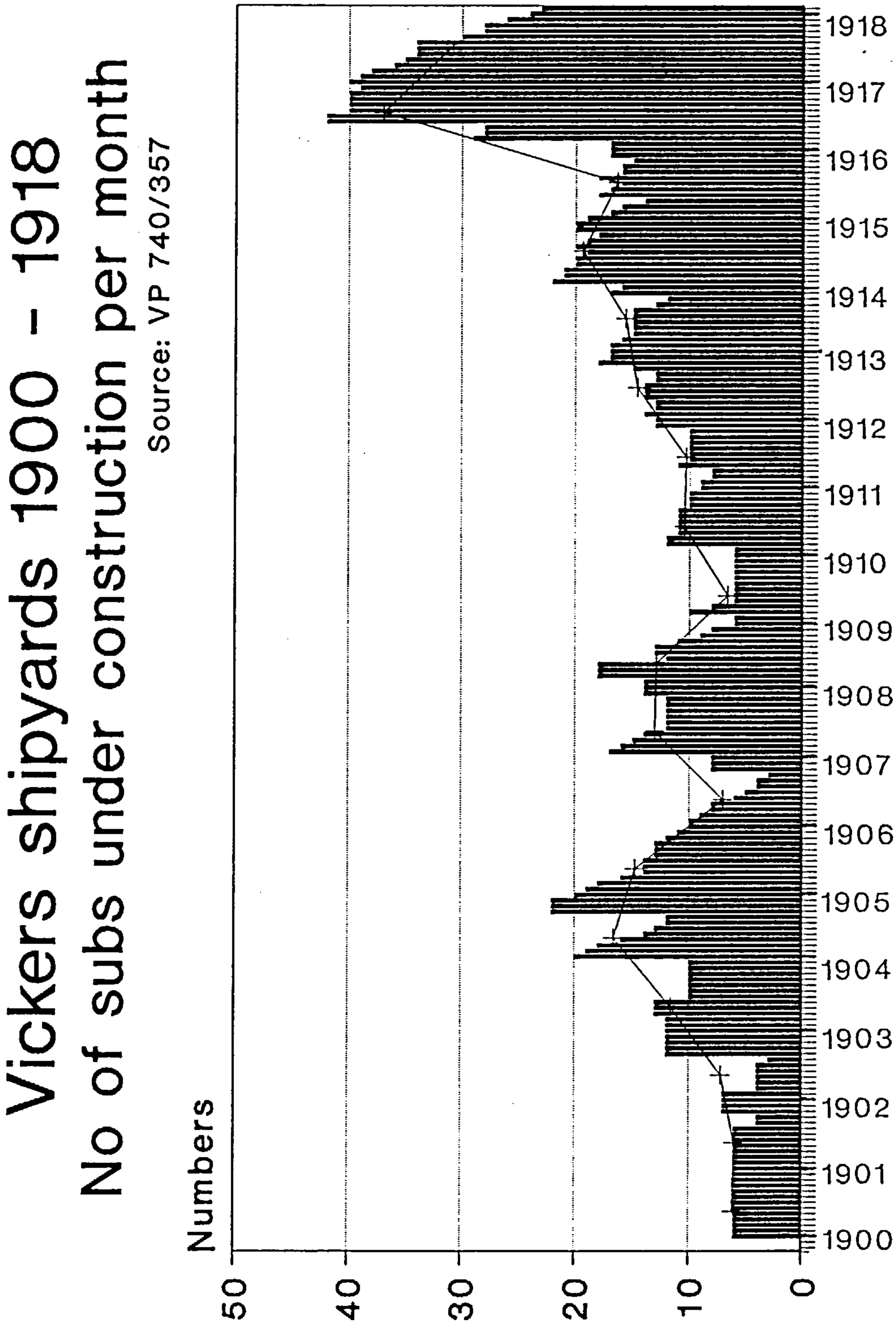
[70] Keyes to Dawson 24 June 1913, VP 741

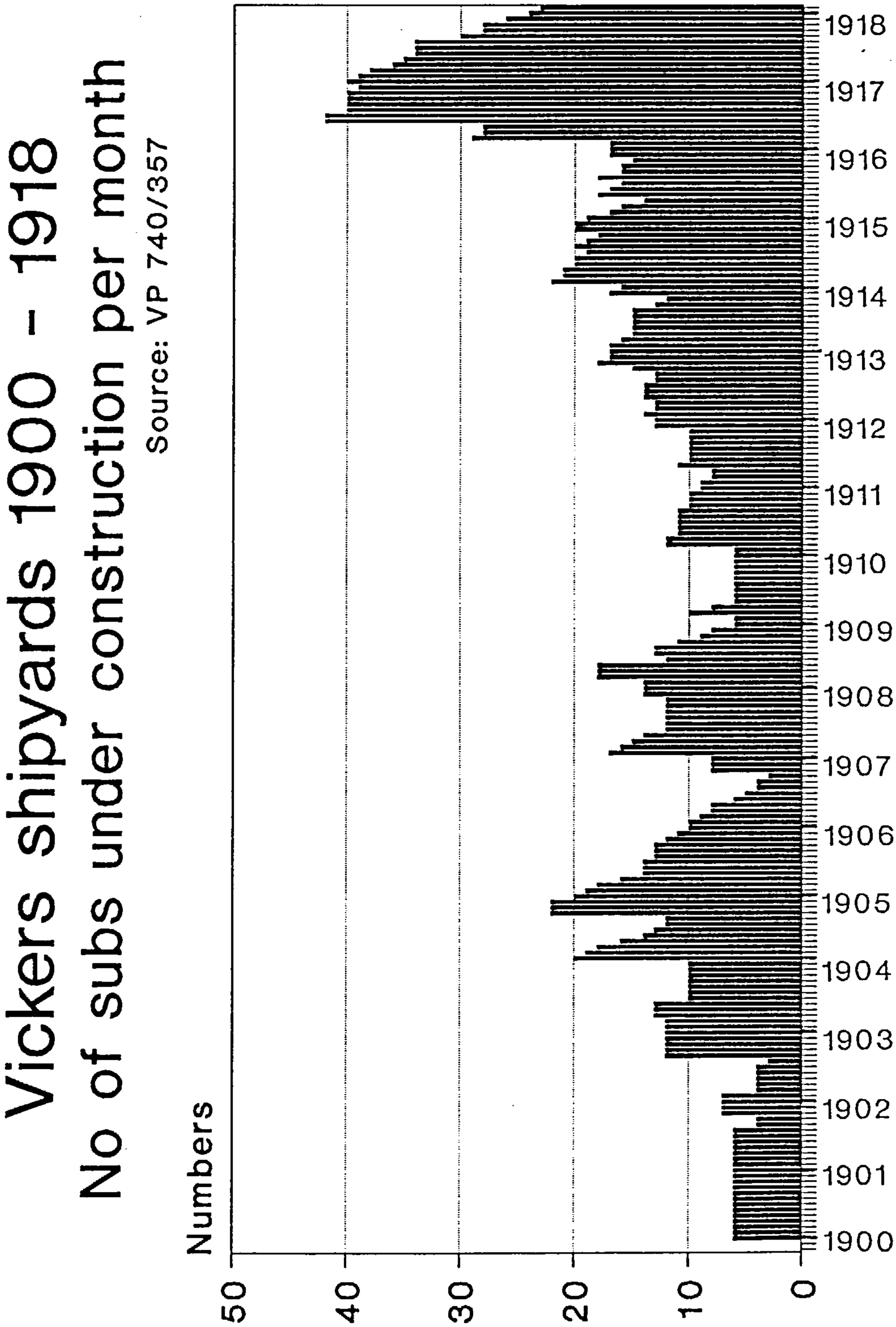
[71] Caillard to McKechnie 25 June 1912, VP 600

[72] Vickers minute book No.6, 16 October 1912, VP 1364 fol.232

[73] McKechnie to Keyes 23 December 1912, Adm 116/3462

[74] Keyes to Committee on Acceleration of Shipbuilding 28 December 1912, ibid


Vickers shipyards
No of subs under construction per month
1900 - 1918
Source: VP 740/357
Numbers
50
40
30
20
10
0
1900
1901
1902
1903
1904
1905
1906
1907
1908
1909
1910
1911
1912
1913
1914
1915
1916
1917
1918
Annual Average
Year


Vickers shipyards
No of subs under construction per month
1900 - 1918
Source: VP 740/357
Numbers
50
40
30
20
10
0
Year
1918
1917
1916
1915
1914
1913
1912
1911
1910
1909
1908
1907
1906
1905
1904
1903
1902
1901
1900

that the recent expansion will enable you to make up lost time. I know that this is very unlikely to happen unless there is some very drastic improvement in the shipyard; you will never pick up unless you take no fresh orders for a year or two!" [75]

By 1914 Vickers itself had to admit that the state of its relations with the Admiralty was "somewhat serious" [76]. The company was still behind with its deliveries, and government protests against the high prices charged for submarines were reaching a crescendo. Vickers was formally rebuked for submitting an excessive estimate for the experimental *Nautilus* [77], and the arms firm was forced to revise its prices for the V class coastals after the Admiralty complained they were "altogether excessive" and warned that "the high prices you are asking for these vessels will be taken into serious consideration when allocating future submarines for HM Navy." [78]

Vickers was now severely burdened by royalties owed to the EBC, which – at £5,000 per boat in 1914 [79] – were much higher than those paid by its competitors to their own licensors [80]. In the immediate pre–war period, Barrow was the most expensive of the Admiralty's major contractors. While the RN estimated that an E class boat would cost £120,000 or less if built in a state dockyard, Armstrong's tender quoted £127,460, Scott's was for £135,000 and Vickers put the figure at £140,000 [81]. Even allowing for EBC royalties, this figure was still high, and the RN's six–boat 1914 order was split 4–2 between Chatham dockyard and Armstrongs. By the time war was declared, Vickers had lost the dominant position it once enjoyed in submarine construction and design. Keyes's patronage went to rival firms manufacturing continental double–hull types quite unlike the Holland submarines.

[75] Keyes to Dawson 24 June 1913, VP 741

[76] Dawson to Zaharoff 14 July 1914, VP 59/134 fols.8–9

[77] Admiralty to Vickers 11 December 1912, Adm 138/362 section 17

[78] DNC dept. submission nd (early 1913), Adm 138/404A section 8; Admiralty to Vickers 13 November 1913, ibid section 12b

[79] Dawson to Zaharoff 14 July 1914, VP 59/134 fols.8–9

[80] In January 1913 Scotts raised the price of its S class boats by 40% to £70,000 each. The Admiralty grudgingly accepted the increase with the proviso that they would expect "a considerable reduction in price in the event of your being called on to submit tenders for similar submarine boats in the future." AW Johns to DNC 29 January 1913, Adm 138/404B section 12; Admiralty to Scotts 17 June 1913, ibid section 12a

[81] Moore memo 18 June 1914, Adm 138/435 section 24

British submarine development 1900–1914

Five major classes of submarine were developed in the period of the Vickers monopoly. The five American Hollands were followed by 13 British–designed A boats, 11 Bs and 38 Cs – usually denoted 'coastal' types – 8 Ds and, eventually, by more than 50 'overseas' Es, the boats that formed the backbone of the submarine service during the 1914–18 war.

The first British submarines to deviate completely from the Holland type were the S and W class boats ordered by Roger Keyes, the fourth Inspecting Captain of Submarines, in 1911–12. Both were foreign coastal types built under licence by British shipbuilders – the S class by Scotts and the W class by Armstrong Whitworth – while the monopoly was being wound up. They were followed by two more small classes of coastal submarines, the Admiralty–designed Fs and Vickers' V class boats, and by two large experimental craft, Vickers' diesel/electric *Nautilus* and Scott's Italian–designed, steam/electric *Swordfish*. Both experimental boats were failures, but they paved the way for the large submarines of the J and K classes – the former diesel/electric and the latter steam/electric fleet boats – produced during the war. Finally, the wartime British submarine service was brought up to strength by 15 double–hulled G class overseas submarines and 10 smaller H class boats, the latter designed by the Electric Boat Company and built under licence by Vickers' shipyard in Montreal [82].

Under the leadership of Bacon, Lees and Hall, there was considerable continuity in British submarine design. The Navy's Holland boats were almost identical to the 107/123 ton (surface/submerged) *Adder* class serving in the US Navy [83]. Bacon developed the A class submarine (built 1900–1908) directly from Holland's plans. The B class of 1904–06 were

[82] A full history of the H boats with a discussion of the pivotal role they played in Anglo–American–Canadian relations in the war years can be found in Gaddis Smith, *Britain's clandestine submarines 1914–1915* (New Haven 1964). See also Robert Hessen, *Steel Titan: the life of Charles M. Schwab* (New York 1975), pp.211–16

[83] Britain's Holland class boats were built from plans supplied by the EBC. The Admiralty had so little control over the design that, although the drawings sent to Vickers contained serious flaws which delayed the construction of *Holland 1* by around three months, it felt unable to intervene to correct the errors. Rear Admiral Sueter to RN Submarine Museum, nd, Submarine Museum A1976/5; see also Frank T. Cable, *The birth and development of the American submarine* (New York 1924) pp.198–203; Bacon op.cit. pp.63–4

described by the Navy as "improved As", and Vickers' protest that the new design was a great advance was not unconnected with its attempt to charge a significantly higher price [84]. The C class (1906–1910) were "B boats with improved internal arrangements" [85], displacing an additional six tons and possessing about the same speed.

Each of the first five Holland boats had a crew of two officers and five men, was armed with one 18" torpedo tube and propelled by a single shaft gasoline/electric motor capable of 7/5 knots. Both the submarines' modest radius of action (250/25 nautical miles) and their lack of any sort of superstructure restricted them to inshore duties; the crew were, in addition, expected to serve in the most primitive conditions, in danger from the gasoline and electric engines – both of which were prone to develop dangerous fumes. Petrol explosions were not at all uncommon in pre–war submarines [86].

From an operational point of view, the Hollands were also comparatively inefficient. When working at or near the surface, the submarines normally progressed by Holland's uncomfortable 'porpoising' method. Their low superstructure made them hard to see, but it also made things difficult for the captain, whose chances of spotting enemy warships were only marginally increased by the provision of a primitive periscope rigged through the ventilator [87].

Holland 1 was launched on 2 October 1901, made her first dive at Barrow on 20 March 1902, and arrived at Portsmouth in the summer of the same year. Sea trials suggested that Bacon's *A1*, at 185/203 tons almost twice the size of the Holland boats and fitted with a six–foot conning tower, would be a more welcome addition to the fleet, and indeed she was a formidable boat for her time. The 103' submarine's brand–new 500hp Wolseley petrol engine – the most powerful yet built – could propel her at 10 knots on the surface (two knots below design speed), and electric motors enabled her to run at 6 knots submerged [88]. Later vessels in the

[84] Vickers to Admiralty 21 May 1903, Adm 138/180B section 35

[85] Watts memo 'New designs of submarine boat' nd (July 1906) Adm 138/360A section 22

[86] Bacon op.cit. pp.59–60; Compton–Hall op.cit. p.40; AS Evans, *Beaneath the waves: a history of British submarine losses 1904–1971* (London 1986) pp.22–3

[87] Compton–Hall op.cit. p.119

[88] Bacon op.cit. pp.68–9

A class managed 11.5/6 knots and had double the *Holland 1*'s radius of action, and *A13*, launched in April 1905, was the first British submarine powered by a diesel engine. She spent much of her working life as an experimental vessel, proving that the new Vickers diesel was considerably safer than a petrol engine and could match the older motors' performance.

As the first submarines designed in Britain, however, the As had serious design faults and, like all the low–buoyancy Holland boats, were particularly liable to plunge under water without warning if a critical surface speed was exceeded [89]. SS Hall considered "the principal defect of this class is their want of endurance in the surface condition" [90], and the boats were obsolescent by 1914.

The first B class submarine came into service late in 1904. The new design, a co–operative effort between Bacon and the Vickers draughtsmen, was an improvement on the As – 40' longer, with two 18" torpedo tubes in the bows and two pairs of hydroplanes, one on the bridge (later moved to the bow) and one astern. These gave the captain greater control over the boat when submerged. Since the Admiralty was still experimenting with diesel engines, the Bs were given 600/190hp petrol/electric motors offering 12/6.5 knots. They had a 370 mile radius of action and, at 280/314 tons displacement (already larger than contemporary French boats), 11 per cent positive buoyancy [91]. Bacon was anxious to improve the speed and sea–keeping of British boats [92], and B class vessels were among the first RN submarines to serve overseas, operating out of Gibraltar and Malta from 1912 [93].

There was little difference between the B class boats and their immediate successors, the 38 vessels of the 286/321 ton C class. But the Cs had electrically (rather than manually) operated hydroplanes, making them more manouevrable, and were the first British submarines with two periscopes – a useful insurance. They were still thought of as coastal

[89] Ibid pp.61–2; Evans op.cit. p.32

[90] Hall 'Memorandum on submarines' 8 April 1910, Adm 1/8119

[91] The difference between surface and submerged displacement. The higher the positive buoyancy, generally speaking, the more seaworthy the submarine, although boats with a high positive buoyancy often rolled excessively.

[92] Bacon report 'Type of submarine boat for 1904, B type' 7 November 1903, Adm 138/180B section 31

[93] Michael Wilson, 'The British B class submarine' parts 1–2, *Warship* vol.5 pp.38–44, 74–9

submarines, but were reasonably seaworthy. In 1911 three C boats made a remarkable journey to Hong Kong, partly under their own power, sailing via the Mediterranean and around India and arriving in the Far East in considerably better shape than the Russian Baltic fleet had done five years earlier. Although the voyage was made under escort and at a comparatively leisurely pace [94], it suggested that the endurance of even the early submarines was considerably greater than was generally suspected. The implications of this discovery were never fully explored, however [see section 4.1].

Though the rapid development of the British submarine service in the years 1901–1914 proved the navy was capable of assimilating novel technology, the conviction that underwater craft were vulnerable, defensive weapons stunted efforts to develop a progressive doctrine for their employment. "I am in no way ashamed to say that Captains of Boats have themselves protested at times of the limitations I have imposed on them," wrote Bacon [95]. And though the nascent War Staff considered using C boats off the German coast as early as 1907–08 [see section 6.3], the specialists of the submarine service (who retained considerable control over submarine design [96]) had less strategic vision and continued to describe the much larger Ds as coastal vessels [97].

The D class was a significant departure for the Royal Navy. The new submarines had nearly twice the displacement of the Cs and were considerably more habitable, thanks to the decision to abandon the Holland single hull design and mount their ballast tanks outside the pressure hull on either side of the superstructure. Their size also made them more seaworthy, though they had only 6% positive buoyancy – less than the 9% of *AI* [98].

[94] Hall 'Report on passage of HM Submarines *C36*, *C37* and *C38* from Plymouth to Suez' 16 March 1911, Adm 1/8213; Kenneth Edwards, *We dive at dawn* (London 1939) p.57

[95] Bacon 'Report on submarine boats' 31 May 1903 enclosure 1, Adm 1/7725

[96] AN Harrison, *Development of HM Submarines from* Holland No.1 *(1900) to* Porpoise *(1930)*, unpublished government paper BR 3043 (1979), section 3.5. Copies in National Maritime Museum and RN Submarine Museum.

[97] Cf. Controller's precis of a 'Meeting of the submarine boat design committee' 24 June 1905, Adm 138/360A section 1; Keyes report 15 August 1913, Adm 138/246C section 49

[98] HG Williams report 'New design D for a submarine boat' 15 May 1905, Adm 138/360A section 2; Lees minute 29 August 1906, ibid section 33.

Considerable caution was displayed in the drawing up of the design, which developed over a three–year period from a prototype only 5' longer than the C class (which were 142') to a fully fledged 163' submarine with diesel rather than petrol engines, twin screws and an extra torpedo tube in the stern to increase firepower and make up for the new class's considerable turning circle. The design was the first to be worked out wholly by Admiralty draughtsmen [99], but Vickers was responsible for the diesels, which were economical and offered a surface speed of 14 knots and a radius of action in excess of 1,250 miles. They were also considerably safer than the old petrol engines, being powered by an inert fuel. The development of such efficient diesel engines revolutionised the potential of the submarine [100] and made overseas patrols a realistic possibility.

The D class submarines were unusual in another way. *D4*, completed late in 1911, was the first British boat to mount a deck gun. A gun armament was of considerable importance to wartime submarines; it gave them a weapon suitable for use in a commerce war against unarmed merchantmen and enabled them to conserve torpedoes for use against more dangerous targets. British boats could not have operated efficiently in the Baltic and the Marmara, as they did in 1915–1916, without guns. It is interesting to note, however, that the early RN submarines were not in fact fitted with guns for offensive purposes. They were supplied as last–ditch defensive weapons for a submarine caught on the surface – to allow the boat to "die hard", as Keyes put it [101]. Bacon saw deck guns as an aid to morale: "At present the knowledge that your sole defence is to skulk below water is not very inspiring – and for destroyers to know that submarines probably will not shed their teeth in firing torpedoes at them, and that beyond this they have no means of retailiation, is decidedly invigorating." [102]

The Es, developed directly from the D class, were Britain's most successful pre–war submarines. The first boats of the class were ordered

[99] DNC memo 1 February 1906, Adm 138/360A section 18

[100] Controller's precis of a 'Meeting of the submarine boat design committee' 24 June 1905, ibid section 1. For the German experience, see Eberhard Rossler, *The U–boat: the evolution and technical history of German submarines* (London 1975) pp.25–32

[101] Keyes report 15 August 1913, Adm 138/246C section 49

[102] Bacon report on B class design 7 November 1903, Adm 138/180B section 31

under the 1910–11 programme and entered service in 1913. Like the D class, they had Vickers diesels and deck guns (it was discovered that the presence of a 12–pdr quick–firer actually improved stability [103]) – and with 18.5% positive buoyancy, the Es were fully capable of operating off an enemy coast. Mounting four or five 18 inch torpedo tubes, they were also more formidably armed than the A (1x18"), B and C class (both 2x18") submarines.

Thanks to their enhanced range, both the D and E class were labelled 'overseas' submarines. Keyes defined the overseas type as boats "for work at considerable distances from their base, with large range of action, able to keep the sea in all weathers, and good habitability, so that the crews of the vessels could live on board in reasonable comfort for lengthy periods." The earlier 'coastal' submarines, on the other hand, were "economical vessels of small displacement" – though "in order that these vessels should carry out their duties efficiently in the winter months, seagoing qualities and good habitability were considered essential." [104]

The gradual evolution of the first Holland designs, and the steady stream of orders that went to Vickers, gave British submarine development a continuity absent from the programmes of other nations. There was a gap of five years between the French order for *Gymnote* (1888) and *Gustave Zede* (1893), and another of six between the *Zede* and *Morse* and *Narval* (1899). French submarine policy was also bedevilled by a dispute between proponents of short range submarines and supporters of the longer–range, more seaworthy submersible [see section 5.3]. In January 1905, for instance, the incoming Minister of Marine (Thomson) cancelled the whole of his predecessor's submarine programme and substituted submersibles [105]. The Germans did not follow *U1* (launched 12 months late in August 1906) until June 1908; the Japanese acquired seven boats during the Russo–Japanese war, but placed no further orders until 1907–08.

The continuity of British submarine development was only broken by the Admiralty's March 1911 decision to end Vickers' virtual monopoly on

[103] Keyes report 15 August 1913, Adm 138/246C section 49; on gun fittings, see also Keyes memo '12–pounder gun as fitted in *D4* – non–suitability for submarines' nd (June 1912), Adm 138/299A section 53a; Hall report 19 December 1909, Adm 138/360A section 75

[104] Keyes report 15 August 1913, Adm 138/246C section 49

[105] 'Foreign naval progress and naval estimates 1906–1907' (France), NID No.834 (September 1907) p.11, Adm 231/48. See also section 5.3.

construction. Under the terms of the agreement, the RN was obliged to give two years' notice of its decision. This meant that no orders for boats incorporating joint Vickers/Admiralty patents could be placed with other British firms until March 1913, and – as we have seen – the Admiralty was forced to allow some of Vickers' competitors to build submarines to foreign designs.

This arrangement was not altogether unwelcome to Keyes. Believing the basic Holland design could not be developed further, and encouraged by a committee of junior submarine officers who had chafed under the technocrats' paternalistic rule and who welcomed the chance to determine policy and examine foreign designs, the new ICS decided to experiment. "We still have a great deal to learn," he wrote [106].

SS Hall's subordinates had monitored foreign submarine development with an increasing sense of unease. French and Italian types were built along novel lines and had many impressive features. They were light and handy, and, in particular, were almost all double hulled, being designed with a thin outer shell surrounding the pressure hull and containing ballast tanks. Unlike the British Holland boats, double hulled craft could be given an outer hull shaped to offer maximum performance on the surface. Keyes particularly disliked the "monstrous" saddle tanks introduced by Lees and Hall, which he thought ruined the surface performance of the D and E class boats and limited their ability to work with surface ships. "The fast Submarine Destroyer... will certainly never develop out of our heavily–built saddle–tank design," he wrote [107].

Once the decision to experiment was taken, it followed that the RN would have to go to foreign yards for double–hulled designs. A controller's department report observed, "our progess in lightening the type without making too great a departure from experience is necessarily slow, and would no doubt be much accelerated by experience with this lighter type of vessel." [108]

Even so, the proposals for future construction put forward by Keyes's submarine committee in 1912 were ambitious. The RN was urged to consider a variety of foreign types, build large experimental submarines and

[106] Keyes report 'Development of British submarines' 6 April 1914, Adm 1/8374/93

[107] Keyes to Hall 19 October 1912, KP 4/22

[108] Admiralty report ?May 1912, Adm 138/361 section 4

order new coastal types to succeed the C class boats. Commander Percy Addison, Keyes's unofficial advisor on submarine design, returned from a visit to French and Italian yards with glowing reports recommending the acquisition of both Laubeuf and Laurenti designs [109].

It was at this point that the submarine branch ran up against the vested interests of the Controller's department. Although executive officers had always been involved in submarine design [110], the Admiralty's naval architects suspected that the new policy involved trespass upon their own territory. They admitted that the 1912 Laurenti design – which had left Addison "very much struck with the boat generally... it is an entirely different type from our own and I submit that we have much to learn from it... the whole arrangement seems extremely well thought out and complete" [111] – would be "quite efficient, and might be regarded as an equivalent of a C class submarine for all intents and purposes", but still worried that "if we are to profit by the skill and experience of the designers it will be necessary to give them a free hand as regards type of machinery, battery &c., imposing no conditions save those of a most general character." [112] In particular, no changes could be made to the lightweight Italian design without increasing displacement and affecting the submarine's seakeeping. That, wrote the naval architect HG Williams, meant accepting "much that our traditions and experience would condemn as unreliable and likely to lead to trouble." [113]

[109] Addison report 12 November 1911, KP 4/2; 'Report as to the immediate future construction of submarines' 9 March 1912, Adm 138/362 section 1. On the importance of the latter report, see Harrison op.cit. section 1.7

[110] Serving officers were actively encouraged to involve themselves in submarine design from the beginning (Keyes to Admiralty 25 February 1914, KP 4/13; Harrison op.cit. section 3.5). The Admiralty played little part in the early design decisions; it was not even sure of the Holland submarines' specifications a few months before the first boats were launched (Controller's minute 4 April 1901, Adm 138/180B section 2). Design work on classes A and B was initiated by Bacon; Lees was largely responsible for the C and D designs and Hall for the E class specifications, although the lines of boats from the A class onwards were decided after testing at the Admiralty tank at Haslar. Detailed design work was the responsibility of Vickers draughtsmen at Barrow, working in collaboration with the ICS, whose own design staff consisted of two part–time assistants seconded from the Controller's department until things were put on a more permanent footing in 1904 (Hall to Keyes 3 January 1912 KP 4/22; Controller's 'Memo re. confidential information in *The Times*' March 1911, Adm 138/299A section 19; Bacon memo 'Staff for submarine boat designs &c.' 19 December 1903, Adm 1/7445).

[111] Addison report 12 November 1911, KP 4/2

[112] DNC to Controller 31 August 1911, Adm 138/404B section 7

[113] HG Williams 'Report on a visit to the works of the Fiat San Giorgio company' 30 August 1911, ibid

The DNC and the Controller objected to the idea of placing orders with foreign firms partly because they believed British designs were inherently superior [114] and partly because they were determined that every sort of warlike store should be available from British manufacturers. The RN's determination to 'buy British' not only dictated the terms of the Admiralty's agreement with Isaac Rice and Armstrong's licensing arrangement with Schneider; it also guaranteed the Dublin optician Sir Howard Grubb – who had built a primitive periscope to Bacon's design in 1901 – a monopoly on the construction of optical instruments despite his inability to turn out periscopes the equal of those in the French, Italian and German navies. This monopoly, which was eventually broken by Keyes's decision to order German and Italian instruments, lasted as long as Vickers' stranglehold on construction [115]. Similarly the Tudor company, which offered a German electric storage battery to the Admiralty in 1907, was denied RN orders after investigation revealed that the firm was partly German owned, though its product was superior to the British Chloride batteries then in use [116].

Unwillingness to order boats from foreign yards forced the naval authorities to hurry inexperienced British arms firms into production. Scotts, the first British firm to build submarines to continental designs, completed three S class boats between 1911 and 1914. But despite having an advanced double–hulled design, considerable positive buoyancy and lighter batteries and machinery than existing British types [117], their unfamiliar and unreliable FIAT diesel engines gave considerable trouble and made the boats hot and uncomfortable to live in. As completed – strictly to FIAT plans, the Admiralty being bound by its agreement with Vickers not to modify the design – they were not really suitable for service outside the calm waters

[114] SS Hall noted that if a design "was accepted by the British Admiralty ...[this]... would at once stamp it as acceptable to other nations. Were our designs scattered broadcast there is little doubt that in a short time foreign nations would be able to obtain them in this country... For adjacent ...[nations]... to be able to obtain an unlimited supply would be very detrimental to this country's interests and would probably necessitate a permanent increase in the strength of our fleet." Hall report 19 March 1909, KP 4/5

[115] Bacon op.cit. p.56; Keyes to Admiralty nd (probably March 1912), Adm 138/246C section 5; 'Development of British submarines' 6 April 1914, Adm 1/8374/93

[116] 'Precis of action taken by Admiralty and correspondence with the Tudor Company respecting trials of their batteries for submarines' nd (1912), Adm 138/246C section 5

[117] HG Williams 'Report on a visit to the works of the Fiat San Giorgio company' 30 August 1911, Adm 138/404B section 7

of the Mediterranean, and all three of the 260 ton, 13/8.5 knot coastals were handed over to the Italian navy after Italy entered World War I.

Armstrongs, meanwhile, was persuaded to go into competition with Vickers by an Admiralty promise of orders for four submarines within two years [118], and the company offered a five year old Schneider–Laubeuf design to the RN. Keyes and Addison protested that the submarine did "not lend itself to our coastal type" and suggested that "if it is absolutely necessary as a matter of policy to place an order for a Laubeuf boat, it is submitted that only one be ordered... it should be preferable to delay the order, increase the length and beam, fit beam tubes and bring the vessel up to the overseas type... Messrs Armstrong Whitworths would then be in a position to compete with Messrs Vickers for the overseas vessels" [119]. But their plea was rejected. The Admiralty was extremely anxious to introduce new private firms to submarine construction as rapidly as possible in order to guarantee supplies of underwater craft, and the Controller replied that the RN was "*honour bound to order* two vessels from Armstrong Whitworths and propose doing so. I think the Submarine Committee will find them much better boats than they imagine." [120]

In fact four boats of the existing French coastal design (developed for the Greek and Peruvian navies) were ordered under the 1913 programme. They were completed during the war, and their brief service careers proved Keyes and Addison right. Although the Laubeuf boats displaced 400/500 tons, their flimsy superstructure and unreliable 760hp Schneider diesels made them unsuitable for the steep seas around the British isles and they too were sold to Italy shortly after their completion.

In the immediate pre–war period, two more classes of coastals were ordered to supplement the now ageing B and C boats. Eight double–hulled submarines of the F class, designed by Admiralty draughtsmen, were ordered under the 1913–14 programme (only three were completed). They kept the old D class armament of 3x18" torpedo tubes and displaced no more than 353/525 tons. The double–hulled V class, designed by Vickers, were given the same radius of action as the Ds and were considered very habitable. Both coastal classes were reckoned suitable for overseas

[118] Controller (Moore) memo 18 June 1914, Adm 138/435

[119] Keyes minute 3 November 1912, KP 4/1

[120] Moore to Keyes 23 November 1912, ibid

operations, and the V class – which were specially designed to dive rapidly [121] – undertook numerous patrols off the German coast during the war.

Keyes's own ideas were incorporated in the G class overseas submarines, the only successful new boats designed during the Commodore's four years with the submarine service. Although only slightly larger than the E class, the double–hulled Gs had 274 tons (28%) positive buoyancy and swan bows, making them extremely seaworthy. They carried four 18" torpedo tubes – two in the bow and two in Hall's favourite broadside configuration – and one 21" tube in the stern. Twin diesel/electric motors offered a respectable 14/10 knot performance, although the large external ballast tanks made the boats slow to dive.

As efficient anti–submarine weapons came into service during the war, this deficiency made all the high–buoyancy submarines developed by Keyes increasingly vulnerable to counter–attack and forced them to spend more and more time on diving patrols, where their superior surface qualities counted for little. The new types were also difficult to build, and firms new to submarine construction foumnd it impossible to meet the delivery dates requested by the Admiralty. The first Gs did not enter service until the end of 1915 – months after the first E class boats ordered under the Emergency War Programme of November 1914 were ready for action.

Keyes's large experimental submarines were less successful and far more complicated than the Gs. Vickers' *Nautilus* was (at 18 knots) only 3 knots faster than the existing 660/810 ton E boats and was considerably less manoeuvrable. But she was 242' long and displaced a staggering 1270/1694 tons. Keyes, who considered it "absolutely necessary that we should build one vessel of this large size in order to be in a position to judge the advisability or otherwise of laying down still larger vessels" [122], did not remain with the submarine branch long enough to take delivery of the boat, which spent five years rather than the contracted 18 months in shipyard hands. Even then, Vickers made such a bad miscalculation in the design of the submarine's giant diesel engines that she was scrapped without seeing service [123].

[121] Admiralty to Messrs Vickers 12 August 1912, Adm 138/404A section 4; Keyes report 15 August 1913, Adm 138/246C section 49

[122] Keyes report 15 August 1913, Adm 138/246C section 49

[123] Addison to Keyes December 1917, KP 4/12; 'Memo on HMS *Nautilus* 2 May 1918, VP 599 fols. 386, 388

Scotts' *Swordfish*, a 231' steam powered submarine with a double hull along 75% of her length, was certainly the most unusual boat built for the Royal Navy in the pre–war period. She mounted two 21" torpedo tubes in the bow and four 18" tubes on the broadside, displaced a very considerable 932/1475 tons and boasted a 3,000 mile radius of action. Her 4,000hp Parsons steam turbines were supposedly capable of developing 18 knots, which would have allowed her to operate as a fleet submarine, and it was this tempting prospect that encouraged Keyes – who opposed steam power as late as 1913 [124] – to approve her construction.

The Commodore was bold enough to claim that "submarine officers welcomed the idea of such a well–tried and simple means of propulsion as the steam turbine" [125], but his plans were condemned both by a "horrified" Hall and by Fisher, who thought the very idea of steam submarines "simply fatal!" [126] Both men pointed to the experience of French steam boats which, like later British K class submarines, were vulnerable to accidents caused by flooding through one of the numerous large hull apertures – notably those required by funnels and ventilators – common in this type of submarine. Moreover steam created operational problems. It was far more difficult to switch from surface to submerged propulsion (the K boats were fitted with no less than five types of motor to surmount this problem [127]), and crash diving was impossible when the funnel was up. Smoke from the engines also robbed steam submarines of their chief asset – invisibility – on the surface, although in practice the diesel powered D and E class submarines also tended to produce excessive quantities of exhaust.

Swordfish's 37% positive buoyancy made her nominally very seaworthy, although a typically Italian low–slung superstructure limited her usefulness. She was the immediate precursor of the infamous K class boats of the Great War – which copied many of her features – and suffered some of the problems associated with steam submarines, being comparatively slow to

[124] Report of conference summarised in 'Warship construction during the 1914–1918 war' 31 December 1918 pp.216–17, Adm 1/8547/340

[125] Keyes report 'Development of British submarines' 6 April 1914, Adm 1/8374/93

[126] Hall quoted in Addison to Keyes, December 1917, KP 4/12; Fisher to Churchill ?October 1913, quoted in Randolph Churchill and Martin Gilbert, *Winston Spencer Churchill* vol.IV p.1955

[127] DNC report 'Warship construction during the 1914–1918 war' 31 December 1918 p.218, Adm 1/8547/340

dive. She also suffered a marked loss of stability in surfacing, and since she proved too slow to operate effectively with the Grand Fleet, she was eventually converted into a surface patrol craft and scrapped soon after the end of the war [128].

For all their deficiencies, it would be wrong to dismiss *Nautilus* and *Swordfish* merely as interesting failures. Hall – who thought the two boats were useless relics of the Keyes regime – wrote them off after taking command of the submarine service again in February 1915, and little effort was made to solve the considerable problems thrown up by the submarines' revolutionary design. Both boats taught the submarine branch valuable lessons in the building and managing of large underwater craft, and though it was certainly unfortunate that Britain dissipated her submarine building resources by multiplying the number of designs under construction in the late pre–war period, as Britain had reason to be grateful for the experience which the arms firms brought in to break the Vickers monopoly had gained by August 1914.

The history of British submarine design and development to 1914 accurately reflected the RN's general uncertainty as to the true value and proper function of underwater craft. The Admiralty's willingness to grant an effective monopoly on construction, the unwillingness of the Controller's office to involve itself in the design process before 1905, and the RN's failure to explain to Vickers and the submarine branch precisely what the boats they were designing were expected to do, were consequences of the decision to buy up the Holland patents to test the capabilities of the submarine, and thus treat it as an experimental vessel, rather than incorporate it fully into the Royal Navy.

Bacon, Lees and Hall were technicians, not fortune tellers. They knew their designs were imperfect, and saw submarines as weapons of considerable but always limited importance which would help implement existing strategy, by protecting Britain against invasion and securing home waters so as to allow the battlefleet freedom of action, rather than as devices capable of changing naval warfare completely and forever.

They produced a series of eminently sound, battleworthy designs – but never claimed or believed, as did the more visionary First Sea Lord,

[128] Addison to Keyes December 1917, KP 4/12; 'Paying off HMS *Swordfish*' 1 May, 10 + 27 August, 23 December 1918, digest cut 11a, Adm 12/1603A; Scotts Shipbuilding and Engineering Co. Ltd, *250 years of shipbuilding by Scotts at Greenock* (Glasgow 1961) pp.95–6

Admiral Fisher, that the submarine was "the battleship of the future" [129], because their minds were focussed on the day–to–day struggle to perfect complex technology and not on strategy and the long–term future of underwater warfare. It was Keyes, the non–specialist, who understood that the submarine service was 'technology led' rather than 'strategy led' and who, with the backing of the Admiralty, instituted a policy of radical experimentation not just in the hope of producing better boats but of developing a more ambitious strategic role for the submarine.

The ten years of the Vickers monopoly helped to dictate the course of early British submarine policy. The Barrow firm committed itself to the Holland design, a low buoyancy type intended for coast defence. Holland boats were provided with dangerous and inefficient petrol engines, and had only a limited radius of action; moreover the ballast tanks of the A, B and C class submarines were placed inside the pressure hull, restricting space, and though the cigar–shaped hull favoured by Holland offered excellent performance when submerged, his boats lacked an upper deck and thus had limited habitability. The spindle form of Holland's submarines also gave Vickers/EBC designs a tendency to dive unexpectedly when running on the surface at high speed. These deficiencies convinced Keyes that large, fast, overseas and fleet type boats could only be developed from the double–hulled submarines favoured by the French and Italian navies.

There was little prospect of ordering double–hull boats from Vickers. By signing a contract with the Electric Boat Company guaranteeing the American firm a half share of the profits on all submarines built at Barrow, of whatever type, the company gave itself no incentive to improve the Holland type by incorporating the best features of continental submarines into new designs. By preventing the Admiralty from passing the Holland patents to other private arms firms, Vickers effectively encouraged its rivals to negotiate with European companies. When Keyes and his submarine committee decided to break Vickers' construction monopoly, therefore, Scotts and Thornycrofts were already able to offer continental designs, and Armstrongs soon followed their lead.

Within the constraints imposed on it by the Holland patents, however, Vickers did much to improve submarine design. The Barrow company was

[129] Fisher paper 'The submarine, presented by Lord Fisher to the Prime Minister *six months before the war*', print of ?March 1917, citing a comment of 1905 reported in *Truth* 4 February 1914, FP 4402

both the most innovative and the most efficient of the major arms firms in the early years of the twentieth century. It successfully developed the diesel engines that made the overseas type possible, increased buoyancy by developing the saddle tank concept, and – with the help of successive Inspecting Captains of Submarines – provided the Royal Navy with D and E class boats that coped well with the demands imposed on them by war.

Whatever the failings of Vickers and the British armament–makers in general, they advanced submarine construction more rapidly and efficiently than had seemed possible in 1900. But perhaps they worked too rapidly; the near obsession with *materiel* that affected many senior officers was detrimental to strategic thought. It was left to the former Prime Minister, Arthur Balfour, to point out the dangers inherent in this state of affairs: "It seems to me almost inevitable," he wrote in 1910, "that our changes in '*materiel*' will out–run the adaptive powers of our Naval tacticians. The ablest man, who has spent his life thinking in terms of 9 inch guns and torpedo boat destroyers, will not easily adapt himself to 13 or 14–inch guns or submarines." [130]

[130] Balfour to Fisher 20 October 1910, Balfour papers Add.Mss. 49712 fol.62

'The Trade'

THE RECRUITMENT AND TRAINING OF BRITISH SUBMARINERS 1901–1918

A volunteer service

In July 1914 the submarine service was an all–volunteer force of upwards of three thousand men, manning 72 submarines attached to 16 depot ships at six naval bases around the world. But its beginnings were considerably more modest.

The first British submarines arriving at Portsmouth in the summer of 1902 were banished to the unsalubrious nether reaches of the harbour with the prison hulks and quarantine vessels, while their trial crews were brought up to strength with the addition of a batch of officer volunteers and men drafted from the battleships HMS *Jupiter* and HMS *Anson* [1]. Even allowing for the crew of Bacon's tender, the 1,000 ton converted gunboat *Hazard*, and the submarine mother ship HMS *Thames*, however, the total strength of the service at this time was little more than a hundred men. These were the pioneers – and tempting though it is to see the early submariners as far–sighted enthusiasts with genuine faith in the future of underwater warfare, the truth is that the crews of Britain's Holland craft were not fervent proponents of the submarine. Most of them had selfish or prosaic reasons for volunteering.

The British submarine service offered a number of inducements to

[1] 'Crews – completion of for first three submarine boats' 6 May 1902, digest cut 11a, Adm 12/1377; Richard Compton–Hall, *Submarine boats: the beginnings of underwater warfare* (London 1983) p.122

young officers and men, of which money was probably the most important. At a time (1912) when the basic pay of an ordinary seaman was 1s.3d. a day, his counterpart in the submarine service was earning 1s.6d. submarine pay on top of the basic rate, and a Chief Petty Officer 2s.6d. extra, thanks to hard–lying money [2]. Officers were even better off. "Those joining the submarine service became dazzled by the rise of 5s. a day," remembered Rear Admiral Vernon Haggard, "and, besides buying a car, were apt to get married as well. As this did not add to their usefulness or efficiency, Commodore Keyes introduced a rule that an undertaking not to marry within the first two or three years should be a condition of their acceptance." [3] Volunteers lucky enough to be appointed to command a submarine did particularly well, for in addition to the hard lying allowance, young lieutenants captaining their own boat were entitled to draw command pay, a rare privilege for men so junior in rank. Commanding officers could thus earn 20s.9d. a day, extremely high wages for the time and more than double the lieutenant's standard 10s [4].

There is little doubt that high pay played a vital part in attracting volunteers to 'The Trade' – the name by which young submariners soon began to refer to their profession. SS Hall believed that "with regard to the pay being in proportion to the responsibilities I would submit that it is, and that in view of the discomforts being undoubtably much greater in the submarine than in the destroyer the proportion is reasonable." Without a monetary inducement it would be impossible to find enough volunteers to keep pace with the rapid expansion of the service [5] – and men tempted by their new–found affluence to marry or sign hire–purchase agreements could not afford to quit the service and return to their old level of pay. The Trade also offered volunteers generous shore leave, and drew many of its crews from the Portsmouth district because that was where most

[2] Pay table dated 1 August 1912 and table (nd) headed 'Comparison of pay of seamen and infantry', Adm 116/1661; Admiralty paper 'Service in submarines' ?September 1913, Adm 116/1122; 'Submarine allowances' 28 July 1915, digest cut 11a, Adm 12/1539B

[3] VH Haggard, Memoirs 1913–1915, undated typescript in the RN Submarine Museum, A1984/42 pp21–2

[4] 'Command money for officers in command of submarines' 13 September 1910, digest cut 11a, Adm 12/1476; 'Memorandum relative to service in submarines...' nd (late 1906) Adm 1/7921; WS Chalmers, *Max Horton and the Western Approaches* (London 1954) pp.5–6

[5] Hall report 12 May 1910, Adm 116/1122. See also Hall to Burney, 27 March 1909, Adm 1/7988

submarines were based [6]. Boats were permanently stationed at the Home Ports, and with rare exceptions they returned to those ports each evening; not for them the inconvenience of months spent at sea. Nor were submariners liable for service overseas before 1910 – another appreciable incentive to join the branch.

A number of additional privileges were granted to the young service. Submariners were allowed to count service in boats as sea–time even if allocated harbour–defence duties – an important concession, since the regulations stipulated that a fixed period of service afloat was necessary to qualify for promotion to the higher ranks [7]. For officers there was the inducement of freedom of action and the chance to experience the responsibilities of command at an early age. Doubtless the dangers and the chance to be a thoroughly disruptive influence in exercises and elsewhere also appealed to some [see section 5.1].

Privileges were necessary to attract recruits to a service that was always on the brink of a serious manpower shortage. The submarine branch was established as an all–volunteer force, since it was considered impolitic to draft men into a potentially hazardous specialisation, and unwise to dilute the quality of the men serving with unhappy and uncooperative General Service ratings. But despite the Admiralty's inducements, volunteers remained scarce and in 1904 the RN was forced to make the Trade a closed service. This meant that for an experimental period – fixed at three years in 1904 and renewed indefinitely in 1907 – submarine COs were forbidden to draft men away to General Service. Instead, officers and men signed on for five years in the branch, to be followed by at least two years' General Service and a possible three further years in boats. Officers were to command submarines for two–year commissions [8]. The initial – and desired – effect of this ruling was to make it difficult for existing volunteers to leave the submarine branch.

The Trade nevertheless continued to expand more quickly than the supply of volunteers. By 1913 even the closed service arrangement was no

[6] 'Memorandum relative to service in submarines...' nd (late 1906), Adm 1/7921

[7] Ibid

[8] 'Meeting to consider submarine manning' 29 August 1904, Adm 1/7644; 'Drafting – ratings in submarine service to be exempt' February 1905, digest cut 11a, Adm 12/1414. See also 'Report by Captain Bacon on the statement that men became nervous after the accident to *A1*', 15 May 1904, Adm 1/7718

longer adequate, and Keyes proposed that unlimited service in submarines be permitted, arguing that the loss of skilled men who had completed eight years and were ineligible for further service, or who were serving their three years with the fleet, could no longer be tolerated. Men should be allowed to spend their whole careers in the submarine branch, the Commodore suggested, noting that "the efficient manning of this rapidly–expanding service is becoming increasingly difficult under the existing regulations." After some haggling with M–branch, the Admiralty acceded to Keyes's request in the autumn of that year [9].

By making the Trade a closed service, the Navy risked producing a highly–trained group of out–of–touch specialists who might be unfit for General Service after their spell in submarines, and who would probably clog advancement in the fleet [10]. But the decision did enable young submariners to devote time to their profession, and the high standards of competence displayed by the British submarine service during the Great War were a direct consequence of the Admiralty's ruling. Although only infrequently allowed to exercise against the surface fleet, and hampered as they were by an overall lack of strategic direction [see section 6.1], submarine officers became masters at handling their craft. The thorough understanding of underwater warfare generally displayed by British submariners compares well with (for example) the contemporary failure of both the British and US armies to develop effective tactics for the machine gun, which recent authorities have attributed partly to the tendency of both services to move young officers from machine gun units before they had really come to grips with the new weapon [11].

The other long–term consequences of the closed service arrangement

[9] 'Memorandum relative to service in submarines...' nd (late 1906) and minutes, Adm 1/7921; Keyes paper 7 February 1913 in Adm 116/1122; Admiralty paper 'Service in submarines' ?September 1913, ibid

[10] Bacon 'Report on training' 8 May 1904, Adm 1/7644 and DNI minute of 4 July 1904, ibid. The case of stokers was especially pertinent: their duties in submarines were quite unlike those of stokers in the fleet, and lack of useful general service experience could render them unfit for the higher ranks. This was recognised by the stokers themselves, and in consequence almost all who passed for Leading Stoker or Stoker Petty Officer immediately left the Trade, invoking an Admiralty injunction that the 'closed service' should not stand in the way of promotion. Report 'HMS *Forth* – stokers serving in submarines' 17 August 1908 and minutes, Adm 1/7979; drafting regulations (revised to 1909), sections 97–101, Adm 1/8034

[11] Cf. Tim Travers, *The killing ground: the British Army, the Western Front and the emergence of modern warfare 1900–1918* (London 1987) p64; David Armstrong, *Bullets and bureaucrats: the machine gun and the United States Army 1861–1916* (Westport, Connecticut 1982) pp.86–88

were probably even more significant. By isolating submariners, to a considerable degree, from the surface navy, the authorities limited the effect that big–ship disapproval of the submarine might have on the development of the Trade. The same policy also impeded the spread of accurate information concerning submarines through the fleet, seriously hampering appreciation of the dangers posed and making it easy for all but the most concerned officers to ignore the underwater weapon. [These points are examined in detail in section 5].

The shortage of suitable volunteers which afflicted the Trade was caused in part by an unwillingness to serve in submarines – the danger, discomfort and claustrophobia must have deterred many. But even those anxious to join the branch had to reach high standards that greatly increased the problems of recruitment. Officer–candidates had to have a first–class torpedo certificate and were generally expected to join the service as sub–lieutenants: "The whole secret," wrote Fisher (who had little to learn from the Jesuits), "is to catch them very young and then mould them while they are so young and plastic and receptive to be just what you want them." [12] Admiralty regulations also specified that submarine officers should be hard–headed, careful, good rough navigators and have reasonable mechanical and electrical knowledge [13].

These rigid criteria were imposed for a reason: the submarine depended almost entirely on her captain for her success. In the days before the invention of sonar and hydrophones, only the officer at the periscope had any idea of what was going around the boat, and only he could pick a target, judge how best to approach her, and then aim and fire a torpedo. "The handling of the vessel remains as it apparently must a one man show," wrote Hall. "However perfect the submarine and her crew, she must be not only useless but dangerous with an indifferent captain, for the moment the vessel dives, i.e. just at the time when she performs her vital duties, the captain being the only man who can see outside the boat controls *and orders everything*; this constitutes the weak point of the submarine, unless the greatest care and discrimination is exercised in

[12] Fisher to Esher 10 March 1904, quoted in MV Brett (ed), *Journals and letters of Reginald, Viscount Esher* (4 vols, London 1934) II, 48–9; Bacon 'Report on training' 8 May 1904, Adm 1/7644; Lees report 'Modifying the system for obtaining officers for the submarine service' 2 August 1905, Adm 1/7795

[13] 'New Admiralty scheme for the entry, training and employment of officers, men and boys for the Royal Navy' May 1903, Arnold–Forster papers Add.Mss. 50285 fols.154–5; 'Selection of officers for the submarine service' 12 January 1912, digest cut 11a, Adm 12/1500

selecting these officers." [14] His successor, Keyes, agreed: "The personality of the captain comes in to a greater extent in a submarine than in any other class of vessel," he observed. "The military value of a submarine is entirely dependent on his skill and nerve, its efficiency on his technical ability, and the lives of his crew on his good judgement." [15] As with the officers, so with the men. To guarantee the safety of the boat, every submariner had to be a first rate hand. The drafting regulations stipulated that all ratings entering the branch had to be literate, and stated: "No man will be passed whose ability is not assessed as either 'superior' or above. 10% of all advancements will be given to ratings whose ability is assessed as 'exceptional'..." [16]

The demands of the submarine service created a number of problems for the RN as a whole. The rapid expansion of the Navy around the turn of the century resulted in widespread shortages of qualified specialists, and torpedo officers and men trained beyond the most basic of standards had never been plentiful. In the early 1890s only five Lieutenants (T) were trained annually; in 1900 four of the 16 available places on the *Vernon*'s course were unfilled and in 1902, seven [17]. Torpedo lieutenants were thus kept in almost permanent employment; with the exception of 1907 there were never more than four Lieutenants (T) on half–pay or extended leave in the years 1900–1912. Nor were specialist ratings readily available. In 1901 the *Vernon* reported a shortfall of 537 Leading Torpedomen and 92 Torpedo Instructors; not until 1905 was there a small surplus [18].

Although the ranks of torpedo lieutenants available for duty in the fleet were not obviously depleted by the demands of the Trade (few submariners qualified as Lieutenants (T) since the syllabus for prospective Lts (Submarines) included a course of torpedo–work), the submarine service did demand a first–class torpedo certificate of its recruits and therefore took up men who might well have otherwise gone on to the *Vernon*'s torpedo

[14] Hall to Fisher 3 August 1909, Fisher papers FP 413, Churchill College Cambridge

[15] Keyes paper 25 February 1914, Keyes papers KP 4/13, British Library

[16] Keyes memo 'Advancements in submarine service' 28 May 1913, Adm 116/1122; see also 'Ordinary seamen for S/M service' 20 December 1917, digest cut 11a, Adm 12/1582A

[17] Alan Cowpe, *Underwater weapons and the Royal Navy 1869–1918* (London University PhD 1979–1980) pp.276–7, 279–81; HMS *Vernon* annual report 1902, Adm 189/22

[18] HMS *Vernon* annual reports 1900–1912, Adm 189 series. The total of Lts (T) available rose from 48 in 1900 to 157 in 1908, falling back to 148 four years later.

course. By 1914 the numbers of lieutenants and lietenant–commanders qualified in submarines had outstripped the numbers qualified in torpdeoes [19].

The peculiar demands of the Trade meant that there was also a perpetual shortage of some classes of rating in the submarine branch itself. Recruitment of petty officers and stokers was never a problem, but the submarine service's insistence on recruiting men with the non–substantive 'Seaman Torpedoman' (ST) rating did give rise to trouble. It was not allowed for under the scheme of complement, "but in practice," M–branch reported, "with very few exceptions, only seamen holding the torpedo rating of ST or above are taken. *No* allowance is made for submarines when calculating the total requirements of STs... the result is a heavy drain upon those men." In January 1913 it was calculated that the submarine service employed 594 of the 4,271 available ST ratings (14%), while the Navy as a whole had a shortfall of 489 STs [20].

The pre–war submarine service also insisted, on the grounds of safety, that its engine–room staff contain a high proportion of Chief Engine Room Artificers and ERAs First Class, depriving the surface fleet of a portion of its best–qualified and most experienced engineers. Not until 1914 did the Commodore (S) concede that submarines had by and large proved themselves reliable and negotiate an agreement that enabled many CERAs and ERAs First Class to be relieved by lower–ranked engine–room ratings [21].

[19] The following figures are extracted from the Navy List –

January 1906:	Lieutenants qualified in torpedoes	108
	Lieutenants qualified in submarines	50
	Submarine Lts qualified in torpedoes	4
January 1910:	Lieutenants qualified in torpedoes	146
	Lieutenants qualified in submarines	69
	Submarine Lts qualified in torpedoes	5
July 1914:	Lts and Lt–Cdrs qualified in torpedoes	139
	Lts and Lt–Cdrs qualified in submarines	170

Some redressing of the balance occurred; it was not uncommon for submariners leaving the Trade to take the torpedo course in the hope of improving their prospects of promotion. Lees report 'Modifying the system for obtaining officers for the submarine service' 2 August 1905, Adm 1/7795

[20] Duff memo 'Non–substantive torpedo ratings in submarines' 24 January 1913 and enclosure, Adm 116/1122. See also 'Complements – ratings overborne' 14 January 1911, digest cut 11a, Adm 12/1488

[21] Bacon report 'Submarine boats and bases – complements...' 4 February 1904, Adm ▶

Much more serious was RN reluctance to provide submarines with specialist signals ratings or adequate signalling equipment [22]. The Navy as a whole was short of wireless operators, and none could be spared for the submarine service. This factor, together with a general failure to fit boats with long–range WT sets, did much to undermine the effectiveness of wartime submarine reconnaissance and patrol, since it was often impossible to report German ship movements to London [see section 6.3] [23].

During the war, the rapid growth of the submarine service and the obvious dangers of life in the Trade caused further manning problems. Regular circulars containing appeals for volunteers were issued, and increasingly strong measures had to be adopted. Late in 1915, "reports of the doings of British submarines in the Sea of Marmara" were issued to the Fleet to stimulate recruiting, and from 1917 all ratings graduating from the torpedo schools were asked (rather pointedly, one imagines) whether they had considered volunteering for submarines [24].

Officer recruitment was generally more satisfactory, both before and during the war, though it sometimes proved "difficult to get the stamp of Officer required in sufficient numbers." [25] But although spare crews were provided for submarines in the ratio of one for every three serving crews, there were never enough officers to provide a trained reserve [26].

One reason for this was that annual wastage in the submarine branch was fairly high. In 1904 Bacon noted that it was running at about one officer in six, and due allowance was made for this figure when planning the expansion of the Trade [27]. The drop–out rate was influenced by

◀ 1/7739; Hall report 12 May 1910, Adm 116/1122; 'Engine room ratings for submarines' 24 September 1914, digest cut 11a, Adm 12/1525

[22] Cf. CG Brodie, 'Some early submariners' part III, *Naval Review* 1963 p191

[23] Keyes minute 15 March 1911, and Bethell (DNI) minute 27 March 1911, Adm 116/1361; Keyes memo 18 November 1912, Adm 1/8269

[24] Cf. 'Volunteers' nd (1915), and 'Report of the doings of British submarines' 15 October 1915, digest cut 11a, Adm 12/1539B; 'Volunteers' 19 January 1916, digest cut 11a, Adm 12/1561A; 'Torpedo ratings volunteering for S/M service' 9 August 1917, and 'Volunteers' 9 October 1917, digest cut 11a, Adm 12/1582A; 'Volunteers for S/M service needed' 29 August 1918, digest cut 11a, Adm 12/1603A

See also Hall reports of 30 August 1916 and late August 1917, Adm 137/2077 fols. 53, 74

[25] Hall report 12 May 1910, Adm 116/1122. See also Hall to Fisher 3 August 1909, FP 413

[26] Keyes memo 18 November 1912, Adm 1/8269

[27] Bacon 'Report on training' 8 May 1904, Adm 1/7644

several factors, including desire to return to the surface fleet, failure to come up to the standards of the Service, and mental strain. It is interesting to note, however, that peacetime figures were actually higher than those recorded during the war. Fourteen officers out of 370 reverted to the general service in 1916 and 30 officers of 570 a year later, ratios of 1 in 26 and 1 in 19 [28]. Presumably patriotism, a sense of duty and the relaxation of standards on the part of the Submarine Service partly account for this trend.

Foreign navies experienced similar problems and ran their submarine services along very similar lines. There was a general agreement that underwater craft should be manned by volunteer specialists serving long periods for high pay. The French created a closed service in which officers and men could enlist for an unlimited period, the minimum being two years. All were volunteers and most were specialists; ratings qualified in torpedo–work were preferred, but some ordinary seamen were borne in the larger submersibles. There was a strict medical examination. New recruits received three months' training, and spare crews were organised in the ratio of one to every five operational boats. Submariners were especially favoured for promotion [29].

Germany too formed a volunteer service, and had no difficulty finding recruits. In addition to hard–lying money, extra pay was awarded for days on which the submarine actually dived. This amounted to 4s. for officers and 1s.6d. for ratings, and compared favourably with allowances in other navies [30]. German submariners were rewarded by unusually rapid promotion – more especially during the war, of course – and as the need for officer–recruits intensified there was a significant drain on the best officers of the High Sea Fleet, which contributed eventually to the rise of indiscipline and incompetence in surface ships. The U–boats usurped the traditional responsibilities of the capital ship, causing much resentment;

[28] Hall reports 30 August 1916 and late August 1917, Adm 137/2077 fols. 53, 74, 80. See also Keyes paper 7 February 1915, Adm 116/1122; CG Brodie, 'Some early submariners' part I, *Naval Review* 1962 pp.428–9.

Unsurprisingly, the most prominent British submariners in the 1914–18 war had served in submarines for years. For example, Charles Little transferred in April 1903, Leir and Cromie in October of the same year, and CG Brodie and Horton twelve months later.

[29] 'Foreign naval progress and estimates 1905–06' (France) NID No.810, September 1906, pp.12–13, Adm 231/47; 'Foreign naval progress and estimates 1906–07' (France) NID No.834, September 1907, p.6, Adm 231/48

[30] 'Foreign naval progress and estimates 1906–07' (Germany) NID No.834, September 1907, p.61, Adm 231/48

towards the end of the war the High Sea Fleet's principal occupation was escorting submarines to and from their bases [31]. In wartime Britain this problem was largely averted; considerable emphasis was placed on co–operation between the submarine service and the fleet. British submarines performed support roles, conducting patrol, recconaissance and anti–submarine operations on behalf of the Grand Fleet.

Most submarine personnel in the pre–war United States Navy were also volunteers, although there was no ruling to this effect. Officers served a three–year 'tour' before returning to the General Service; they were then free to volunteer for a further spell in boats. Ratings were generally specialists "of excellent habits as to steadiness, sobriety &c." They too had to serve three years in the submarine service. Special attention was given to overcoming the problems of stagnant promotion which bedevilled a closed service with a static *materiel* base, and ratings qualified for promotion were held in reserve until they could be transferred to a newly–commissioned boat at the higher rank [32]. The Russians, meanwhile, made an effort to improve the quality of their submarine personnel by establishing a training division in 1905. Enlisted men received higher pay and accelerated promotion, but there was a shortage of officers willing to serve in boats [33]. The Imperial Japanese Navy introduced something akin to the British system. Its submarine branch was an all–volunteer force, and the supply of men considerably exceeded demand. Officers were expected to serve two 'tours' of two years each, interspersed with a spell of General Service. Although conscripts could volunteer, most submarine ratings were long–service men. It was anticipated that they would be retained for two or three years, after which their efficiency would begin to decline [34]. All these navies were thus agreed that the dangers and discomforts of submarine life would soon exhaust personnel; all were certain that the incentive of extra pay was vital, and all organised spare crews and a system of reliefs. Crew endurance was considerably under–estimated.

[31] Holger Herwig, *The German naval officer corps: a social and political history 1890–1918* (London 1983) pp191–4

[32] 'Foreign naval administration and personnel' (USA) NID No.870, August 1910, p.54, Adm 231/52

[33] DW Mitchell, *A history of Russian and Soviet seapower* (London 1976) p.276

[34] 'Japan: fleet, dockyards &c.' in 'Reports on foreign naval affairs 1907' vol.1, NID No.815 p.86, July 1907, Adm 231/47

Crew health and endurance

Before 1914 it was widely believed that human stamina – rather than mechanical or logistical shortcomings – would dictate the time a submarine could spend at sea. The boats which the Royal Navy's pioneer submariners sailed were so cramped and so unhealthy that, according to Fisher, "the only limit to their marvellous efficiency... is the endurance of the crews" [35]. A 1903 paper suggested that the mental strain of service in the submarine branch would undermine the professional competence of any officer within two years [36].

The submarine was a small, enclosed craft. British crews were not normally expected to live on board, being billeted in depot ships, and conditions therefore became cramped in the extreme during protracted spells at sea. The air was polluted by petrol or diesel fumes; the boat was unpleasantly hot in summer and decidedly cold in winter or under water. Most submarines reeked of food and frequently of vomit; in the early boats the toilets were no more than pails. It was impossible to keep clothes dry. Underwater craft were usually damp with condensation, and water cascaded through hatches located only feet above sea–level. In particularly bad weather these were battened down, but even in calm seas few of the crew got much fresh air.

In wartime a submarine might frequently be closed up and remain submerged all day, leaving the air so foul that matches would not burn. Boats were claustrophobic and even in peace there was always the fear that something would go wrong, that the crew would be crushed as the hull split apart under the pressure of water, or left to suffocate slowly on the bottom after an accident. The men of the Trade earned their hard–lying bonus: "It is only after going on board a submarine on her return... that one realises what a tremendous strain is imposed on the personnel," wrote Commodore Hall in 1916. "They are all young men in the prime of life who have undergone rigorous selection for fitness, but they are obviously much tried after seven or eight days during which they are continually in

[35] Fisher paper 'The oil engine and the submarine', December 1913, FP4293/9

[36] 'Submarine personnel', April 1903, in *Naval necessities* II p.455, Adm 116/3093. See also 'New Admiralty scheme for the entry, training and employment of officers, men and boys for the Royal Navy', May 1903, Add.Mss.50285, fols.154–5

what constitutes 'action' to a submarine." [37] Submariners, in short, were required to display "two o'clock in the morning courage for the whole time they are at sea." [38]

In recognition of the dangers and discomfort of life in a submarine, hard–lying pay was awarded as early as November 1901 [39] and was, as has been seen, a key factor in securing volunteers. The early coastal craft were of course the most uncomfortable; on *A1*'s maiden voyage (from Barrow to Portsmouth) "the crew had a very unpleasant time", as Bacon recorded:

> "Here they were boxed up in a confined space, practically cut off from outside help, rolling and pitching sharply and considerably, with the incessant roar of breaking seas all round the hull, suddenly finding appliances they trust to, and whose scientific action they only partially understand, evidently going wrong. Pungent and irritating fumes, the exact nature of which they are ignorant, are given off and affect their noses eyes and throats – naturally tales of explosions and poisoning in submarine boats, so sedulously propagated by our sensational press, must have occurred to their minds. Yet through all this 'Unknown' they keep their heads and preserve excellent discipline. Surely it is occasions such as this that throw a prophetic light on what the behaviour of our personnel will be in time of war!" [40]

Submarines of the B and C classes were hardly more luxurious, and although conditions improved somewhat in the overseas boats, with their greater displacement and higher conning towers [41], Keyes remembered. "that the hardy fishermen of the North Sea hailed the submariners of those days as comrades, and always threw fish to them when the weather

[37] Hall report 30 August 1916, Adm 137/2077 fol.57. For conditions, see also Hall's vivid report of 12 May 1910, Adm 116/1122; Cecil Talbot's account of his first trip in a submarine, diary entry for 13 April 1904, Talbot papers 81/42/2, Imperial War Museum; and of course the extensive secondary literature.

[38] Hall report late August 1917, Adm 137/2077 fol.78

[39] 'Extra pay for submarine crews' 4 November 1901, digest cut 11a, Adm 12/1365

[40] 'Submarine *A1* – report by Inspecting Captain of Submarines on passage from Barrow to Portsmouth' 3 August 1903, Adm 1/7644

[41] Hall minute 20 April 1910 to Report No.1 of Submarine Committee, quoted in the *Technical History* vol.40 p.12, Naval Library MOD

permitted." [42]

There was real concern for the health of men in such a working environment. Both officers and men were given careful physical examinations upon volunteering, and periodic reports were made thereafter by a naval surgeon. The ratings, confined below, were thought to be especially at risk, not least from petrol engine fumes – hence the presence of a cageful of white mice, suspended over the engines where they would give early warning of escaping gas "by turning up their little feet" [43]. Officers were reckoned more susceptible to purely mental stress, although the odd case of periscope–induced eyestrain was diagnosed; with officer efficiency at such a premium, the afflicted individuals were swiftly invalided out of the service [44].

By 1904 Bacon was agitating for more submarine officers, noting, "I have had the conviction forced on me that we cannot rely too much on the officers trained forming an efficient reserve – since I am convinced that the mental and nervous strain, on the Captain of a Boat, tells on him in time, and that with increased service in Boats the essentials of a good captain more often decline than increase." [45] But with both space and air in short supply, it was important to keep crew numbers down, and even men exercising on a daily basis and returning to port each night were exhausted by the continual round of work – which included recharging batteries and air reservoirs in the evening. Such conditions soon led to "a general lowering of their state of health, making them less alert and rather more what is commonly called 'jumpy'; not exactly nervous but with a tendency in that direction." [46] For a time Bacon was forced to restrict training at sea to alternate days.

In 1905 the Admiralty reckoned the seagoing endurance of contemporary submariners at three days in good weather, less if conditions were bad. In

[42] Keyes NM I, 40–1

[43] Compton–Hall op.cit. p.124; RWG Stewart 'Medical report on the health of officers and men employed in submarine boats' January 1904, Adm 1/7719; Hall report 12 May 1910 in 'Submarine service – recruiting for service in submarines' Adm 116/1122; 'Physical requirements' 31 March 1910, digest cut 11a, Adm 12/1476

[44] 'Officers suffering from eyestrain' 17 September 1918, digest cut 11a, Adm 12/1603A; CL Kerr, *All in the day's work* (London 1939) pp.128–9

[45] Bacon, 'Report on training' 8 May 1904, Adm 1/7644

[46] Bacon report 'Crews for submarine boats' 29 May 1903, Adm 1/7666

the boats of 1910 it was calculated as between four days and a week, and SS Hall cautioned that "these times must not be exceeded." [47] The experiments of the Submarine Committee confirmed that in practice crew endurance was the greatest limiting factor in mock operations [48], and the Controller's Department acknowledged that "habitability has been seriously considered and... too much stress cannot be laid on its importance from the point of view of the health and endurance of the personnel. It is considered that the lack of habitability in our submarines places a limit on their range of action." [49]

Pre–war estimates of crew endurance had a marked effect on the development of British naval policy. If submariners could tolerate no more than three or four days at sea, it was difficult to conceive of an effective overseas submarine – particularly one that could operate in the Atlantic Ocean. The implications were equally serious for any attempt to blockade the enemy's coast with submarines, since the number of boats needed for an effective operation leapt dramatically when low endurance was taken into account. If a submarine took a day to reach her appointed station on the German coast, for example, and a day to return, spending one day on patrol, at least five boats would be needed to cover that patrol area: one on her way to the Bight, one patrolling, one returning to port, the fourth replenishing and the fifth refitting with her men on leave. But if a submarine could patrol for a week or more, only three craft would be needed to cover the same area. When Henry Jackson, the Chief of Staff, suggested in 1913 that three flotillas of 12 overseas submarines might be enough to blockade the German coast, one flotilla being on station at any given time, Keyes argued four flotillas would still be preferable [50].

Development of coastal submarines, on the other hand, seemed a much more practicable idea. Coastals were intended to return to a local port each evening, handing over their responsibilities to surface torpedo craft by night. Given help in recharging batteries and air bottles, crews assured of billets on a comparatively comfortable depot ship could patrol day after day, their

[47] 'Meeting of the submarine design committee on 23 June 1905' (precis by Jackson dated 24 June 1905), Adm 138/246A section 1; SS Hall, 'Memorandum on submarines' 8 April 1910, Adm 1/8119

[48] Submarine committee report no.4, 12 August 1910, Adm 1/8128

[49] 'Report as to the immediate future construction of submarines' 9 March 1912, Adm 138/362 section 1

[50] 'Record of conference held in First Lord's room on 9th December [1913]', KP 4/10

endurance limited only by the mechanical shortcomings of their boats. The idea of providing a submarine cordon for Britain's coasts thus seemed not altogether unrealistic [see section 6.2].

British estimates of low crew endurance also emerge as one of the key factors in the RN's persistent tendency to under–estimate the potential of enemy submarines in the pre–war period. A number of factors combined to mislead the Navy. Recollection of the appalling conditions suffered by torpedo boat crews remained strong [see section 1.4]. In 1884, for example, the *Vernon* noted that "the question of cooking is of no importance if the boats are forced against the sea, because there is so much shaking, caused by vibration, that even a crew of the most inured sailors are not in a fit state to appreciate a colossal meal" [51]. Equally telling was the Navy's unwillingness to subject its submariners to particularly trying conditions before 1914; the supply of volunteers was always problematical, and the pre–war submarine service had to make some concessions to the comfort of officers and men who, in time of war, were prepared to make sacrifices and endure conditions that might have led to mutiny in peacetime. And, finally, the RN failed to adapt judgements based on the performance of early submarines as later, more capable types came into service. There was a world of difference between the endurance estimates of 1905 and those of 1910, and – though this was not widely recognised – a similar revolution in submarine habitability was effected between 1910 and 1914.

The Admiralty's pre–war solution to the problem of crew endurance was to provide 'spare crews' who could do maintenance work and recharge batteries, besides relieving their fellow submariners at regular intervals – perhaps even at sea. There were several advantages to this system: the reserves were available to train up new recruits to the rapidly expanding service, and they added to the nucleus of experienced submariners, which proved invaluable when submarine construction began to speed up. Spare crews also increased the proportion of active submariners in the submarine service – a factor of concern to the Mobilisation Branch, which nevertheless complained in 1912 that of 2,800 men borne no more than 901 were in boats at any one time [52].

[51] Cowpe op.cit. p.119, citing HMS *Vernon* annual report 1884, Adm 189/4

[52] Duff memo 21 December 1912, Adm 116/1122. The balance of 1,900 men was made up of the spare crews and support staff based on the depot ships.

Bacon's instinct was to press for double crews, but this measure would have exacerbated the problems of recruitment, and was in any case deemed a needless luxury. A compromise of one spare crew for every three boats was reached in 1903, and this system operated until 1914. Late in 1915 the pressure of war and the increased seaworthiness of overseas submarines led to a reduction in the number of spare crews borne [53].

As the spare crew system grew in complexity, concentration on what should have been at best a stop–gap solution to the problem of crew endurance undoubtedly impeded British reconsideration of the issue. The Admiralty continued to believe that, despite their superficially impressive radii of action, German boats would not be able to operate efficiently off the Scottish coast – some 500 miles from their bases and much further from home than British submarines sailing from Harwich to the Bight – let alone along the Atlantic shipping lanes. The Intelligence Department thought that "none of the first twelve German submarines are fit for the open sea", and reported that the endurance trials of the submarines *U17* and *U18* – which consisted of the voyage from Kiel to Sylt and back, a distance of about 600 miles each way – ended with "practically every member of the crews in a state of exhaustion. They speak warmly of the nautical qualities of the type, but complain of the habitability." Only "under stress of emergency" would these later boats remain at sea "for many days on end", though they were otherwise "well able to operate in the open seas even in winter" [54].

The RN does not seem to have appreciated the implications of the 1912 German naval manoeuvres, which saw U–boats keep the seas for up to eleven days, and which led the Kaiser's naval authorities to conclude that war patrols off the British coast of up to five days' duration were possible [55]. Nor did it have time, before the outbreak of war, to react to the news that U–boats of the *U31–41* class possessed a theoretical range of almost 8,800 miles at 8 knots. When German submarines appeared off the Scottish coast shortly after the outbreak of war, Jellicoe was convinced they

[53] Bacon report 'Crews for submarine boats' 29 May 1903, Adm 1/7666, and minutes to this report; Hall memo for Admiral May 25 February 1910, Adm 1/8119; 'Spare crews' 6 November 1915, digest cut 11a, Adm 12/1539A

[54] 'New German submarines' 19 January 1914, War Staff report in Adm 138/246C section 45d; Carl–Axel Gemzell, *Organisation, conflict, innovation: a study of German naval strategic planning, 1888–1940* (Lund 1973) pp.61–2

[55] William Jameson, *The most formidable thing: the story of the submarine from its earliest days to the end of World War I* (London 1965) p.111

were operating from tenders in the North Sea disguised as neutral merchant vessels [56].

It is hard to over–state the importance of Britain's misconception. Failure to anticipate the true endurance of German submarines left UK ports without submarine defences in 1914 [see sections 7.2 and 8.1], and thus had a considerable effect on British naval strategy in the first months of the war – a period in which the battlefleet was often kept at sea far from the likely war zone for fear of submarine attack. Without defended ports, the Grand Fleet was also unable to support the transfer of the Expeditionary Force to France, which duty was left to the old battleships of the Channel squadrons. Lack of protected bases could thus have rendered the RN at a decided disadvantage had the High Sea Fleet adopted a more aggressive stance in 1914.

Submarine safety and morale

When HM Submarine *A1* sank on 18 March 1904, she did so with all hands – two officers and nine men – and ended the remarkable forty–year safety record of the submarine boat. Her crew were the first submariners to lose their lives since Flach's boat went down in Valparaiso harbour, but seven more British submarines were to be lost before August 1914 – *C11*, *A3*, *B2* and *C14* in collisions, *A4* by flooding, *A8* after a battery explosion and *A7* in an accident caused by a design fault. There were in addition several near–disasters – more explosions, narrow escapes from swamping and the consequences of diving too deep, non–fatal collisions. The trick, for the officers of the Trade, was to persuade the Navy, the public and themselves that the submarine was not inherently dangerous. Submariners argued that British boats were simply suffering teething trouble. This was broadly true, but it meant the problem of safety never received adequate consideration [57]. Tell–tale signs that all was not well with the A class design, in particular, were ignored because successive

[56] Eberhard Rossler, *The U–boat: the evolution and technical history of German submarines* (London 1975) p.328; Jellicoe to Admiralty 14 November 1914, Adm 137/965 fol.167

[57] Cf. Bacon, 'Notes on the causes of accidents to submarine boats and their salvage', TrINA Vol.XLVII (1905) p.404

Inspecting Captains felt they had to prove the submarine to be a viable weapon. "The attitude of the official mind was one of lukewarmness, and general scepticism as to the reliability of submarine boats," wrote Bacon. "Any accident would have given an opportunity for the ignorant to revile and say, 'I told you so.'" [58] He and his successors could not afford to admit that mistakes were being made.

Because the submarine operates in a hostile medium, any accident is potentially a serious one. For a surface warship to go down with all hands is rare; in submarine warfare it is commonplace – and particularly so in the early years of the century, when safety came a poor second to operational efficiency. A good example of this rule was the British decision not to fit watertight bulkheads in their submarines on the grounds that they would impede the passage of orders [59]. The first RN boats to have bulkheads were those of the E class [60].

Early attempts to improve safety standards were complicated by the fact that pre–war mishaps and disasters fitted no particular pattern. Put simply, fatal submarine accidents could result in the crushing, gassing or drowning of the crew. Many were caused by the vulnerability of the submarine underwater, particularly to collision in exercises; SS Hall called the submerged boat "an invisible vessel worked by a one–eyed man in rather bad light with an horizon of about one and a half feet and a field of only 40^{o} at any one time." [61] A great deal of effort was therefore put into making manoeuvres safe, with consequences that are examined in section 5.2.

The men of the Trade nevertheless understood that in the event of an accident their chances of escaping were slim. Hall once went so far as to suggest that the provision of any safety devices was inadvisable – they lowered morale by reminding of danger, the ICS asserted [62] – and

[58] Bacon, *From 1900 onward* (London 1940) p.66

[59] Hall statement reported in TrINA XLIX (1907) pp.59–60; see also Hall report 12 May 1910, Adm 116/1122; Bacon in RUSI Jo. XLVIII (1904) p.1304. The presence of watertight doors might have saved several lives in pre–war accidents, but in the absence of other safety features they would generally have been of little real use.

[60] Watts report 'Submarine boat design of the FIAT San Giorgio', August 1911, Adm 138/404B section 1; ET d'Eyncourt, *A shipbuilder's yarn: the record of a naval constructor* (London nd [1949]) pp87–88

[61] Hall report 12 May 1910, Adm 116/1122

[62] Hall submission, nd (c.18 May 1908), Adm 116/1057. Similar arguments were deployed when it was proposed to issue RFC pilots with parachutes during the Great War.

certainly Germany's earliest volunteer submariners can hardly have been encouraged to learn, shortly before their first dive, that a grateful Admiralty had just insured their lives for £2,500 apiece [63]. Over the years, British submariners learned to take refuge in grim humour when on duty and in drink during their leisure hours; it is hardly surprising the Submarine Service contained an unusually low proportion of teetotallers [64].

If the worst did happen, the submariner had two broad options – escape, or wait for salvage. At first the general expectation seems to have been that a stricken submarine could quickly be raised and her crew saved, but in fact salvage was rarely a viable idea. All too often bad weather prevented lifting for weeks when the life expectancy of a trapped crew was measurable in hours and days [65]. The Admiralty also declined to fit British craft with drop keels, which had been used from the earliest times to give boats extra buoyancy in an emergency, because it was expected that any accident severe enough to sink a submarine would be too sudden and devastating for a drop keel to be of any use. This opinion was only grudgingly revised after the detachable keel of the French *Bonite* saved her crew after a collision in February 1906 [66].

Later efforts concentrated on individual life–saving apparatus. Devices such as enclosed lifeboats for the crew (as had been fitted to *Le Plongeur*

[63]'Germany – fleet, dockyards &c.', September 1906 in 'Reports on foreign naval affairs 1906' NID No.804 pp.32–3, Adm 231/46

[64] The following figures have been extracted from 'Encouragement of temperance in the navy' 4 December 1908, Adm 1/7996 [**Submarines** = depot ships *Mercury*, *Thames*, *Hazard*, *Forth*, *Bonaventure* and attached boats. Sample 1,438 men. **Royal Navy** = Home ports; Home, Channel, Mediterranean and East Indies squadrons. Sample 68,405 men]:

(a) Proportion of Temperance men:
Submarines 7.3% Royal Navy 13.4%

(b) Proportion of grog men willing to sign pledge in return for extra pay of 1d. per day:
Submarines 7.2% Royal Navy 17.8%

It is also interesting to note that Russian submariners made up the hard core of Bolsheviks in the Baltic Fleet. 210 of the branch's 775 men (28.5%) were Party members in 1917. See Jacob Kipp, 'Undersea warfare in Russian and Soviet Naval Art: historical background 1853–1941', paper presented to Undersea Warfare Conference, Dalhousie University, Halifax, 21–24 June 1989.

[65] In 1917 lives were saved on *K13* by partial salvage. However this submarine was on trial near a major naval base, so the circumstances were unusual. See Don Everitt, *The K boats: a dramatic first report on the Navy's most calamitous submarines* (London 1963) pp55–91

[66] Lees in TrINA XLIX (1907) p.56; Bacon in RUSI Jo. XLVIII (1904) pp.1303–04; DNC 'Memo re: detachable keel in *Nautilus* and *V1–4*' 5 December 1913, Adm 138/404A section 15

in the 1860s) were dismissed as clumsy and liable to break free and so betray the submarine's position in war – as, incidentally, were the telephone buoys intended to allow communication with a stricken vessel that were fitted to the boats of several other nations. Because the chief avoidable danger came from gas, some attention was given to the Hall–Rees helmet – a precursor of devices such as the Davis Submerged Escape Apparatus and the USN's Momsen Lung – but its bulk made it unpopular with crews. So did its reliance on the decomposition of sodium peroxide to produce oxygen; the chemical burst into flames when it came into contact with water [67]. Refinements such as escape chambers had no place in the small pre–war submarines, and in general it must be admitted that provision for escape was poor before 1914. There is little doubt that some lives were needlessly lost. On the other hand the Navy did learn from its mistakes, and disasters helped to accelerate the development of the diesel engine (far more reliable than its petrol–fuelled predecessor), watertight doors, and double–hulled high buoyancy submarines.

It seems unlikely that the doubtful safety record of the British submarine had much effect on the phlegmatic submariners' morale, and belief that the type was dangerous, being implicit, helped to blunt criticism when accidents did occur. There was a feeling that such incidents were inevitable in a navy which devoted itself to realistic preparation for war; accidents were the price that had to be paid for increased operational efficiency. As Admiral Fisher put it to one journalist after the *A1* went down, "the right thing to say *a propos* of the submarine loss is that you can't have an omlette without breaking any eggs." [68]

Captain R.H.S. Bacon (ICS 1900–1904)

Few billets in the Navy offered the freedom of action enjoyed by the Inspecting Captain of Submarines (ICS). Each ICS co–operated closely with Vickers, supervising every aspect of the design, development and construction of submarines, and was given a largely free hand in developing

[67] The Admiralty case 'Submarine life–saving 1907–1913', Adm 116/1057, is chiefly concerned with the Hall–Rees helmet; see also WO Shelford, *Subsunk – the story of submarine escape* (London 1960) pp.30–1

[68] Fisher to Newbolt 2 May 1904, FP 5416 (in bundle headed 'Navy reform'); see also Kerr minute 21 March 1904, Adm 1/7718

tactics and devising training programmes for the Trade. Admiralty supervision was unusually loose, and the personal interests and prejudices of each ICS became important influences on the development of British submarine policy. It is therefore necessary to say something of the character and abilities of the first four Inspecting Captains of Submarines.

The first ICS was Captain Reginald Bacon (1863–1947). He entered the Navy in 1877, qualified as a torpedo lieutenant and commanded a flotilla of torpedo boats in the manoeuvres of 1896. In 1897 he served as a member of the punitive expedition to Benin City and was awarded the DSO, describing the experience in the first of his several books, *Benin: city of blood*. In 1899, while serving as a commander in the Mediterranean fleet, Bacon met Admiral Fisher and was swiftly drawn into the circle of young officers employed by Fisher as an informal staff. Promoted to Captain in 1900, he left the Mediterranean Station and was appointed to command the new submarine branch [69].

By 1900 Captain Bacon had been singled out as a most promising officer. He was the acknowledged possessor of a fine technical brain, and Admiral Fisher's enthusiasm for his abilities can hardly have hindered his career. That the Admiralty shared Fisher's opinion of Bacon is evident not just in its decision to appoint so junior a captain to a comparatively senior position but in the laudatory minutes that attached themselves to his earliest reports [70].

Bacon was well–qualified for his new posting, having served in the torpedo service throughout the 1890s. He had spent several years on the staff of HMS *Vernon*, and his character was dominated by a flair for things mechanical. He developed one of the first practical modern periscopes and produced efficient submarine compasses. Later in his career Bacon made a significant contribution to the development of the *Dreadnought* design, was appointed Director of Naval Ordnance and then Managing Director of the Coventry Ordnance Works, where he developed siege guns for the BEF before taking command of the Dover Patrol (1915–18) and conceiving several bizarrely–ingenious methods of bombarding the enemy's coast. After his retirement he settled down to write books with titles like *A simple*

[69] Bacon's autobiography appeared in two volumes: *A naval scrapbook 1877–1900* (London 1932) and *From 1900 onward* (London 1940). He left no private papers.

[70] Minutes to Bacon report 'Complements for submarines' 27 July 1901, Adm 1/7533. See also minutes to Lees, 'Submarine flotilla – 2nd annual report on' 1 March 1905, Adm 1/7795

guide to wireless for all whose knowledge of electricity is childlike [71].

Few of Bacon's contemporaries denied his brilliance, but many felt that he was also blinkered, arrogant, slow to acknowledge his mistakes and a poor leader of men. There is no doubt that the ICS's mastery of the technology with which he dealt reinforced the independence of the submarine branch; he was a remote and stubborn centraliser who rarely admitted he needed help from anybody. "I must insist," he wrote in rejecting one practical suggestion, "that my experience as to the performance of boats is greater than that of many critics who have never seen an attack being made." [72]

Bacon was right far more often than he was wrong – but when he did make a mistake it could be serious. This weakness became more pronounced later in his career (as Admiral commanding the Dover Patrol, for instance, he persisted in the belief that German submarines were not passing through his channel mine barrage in the face of clear evidence that they were), and it does not seem to have manifested itself strongly while he commanded the submarine branch – but the trait did underpin the unfortunate knack which Bacon developed of polarising the opinions others held of him. He was not, like Keyes, a friend to all men. To Maurice Hankey, during the war, he was "the one officer with offensive spirit"; to Tyrwhitt of the Harwich Force a worse enemy than the Germans, unwilling to take risks and "our bugbear... the Streaky One has obsessed everyone at the Admiralty and does exactly what he pleases with them... You will understand me when I say he is not a white man." [73]

This said, it must always be remembered that the odium which still attaches itself to Bacon's name was earned long after he left the submarine service. In 1906 he returned to the Mediterranean under Fisher's *bete noir*,

[71] For a naval officer, Bacon was something of a polymath. He also wrote poetry (for which he could find no publisher) and fiction peopled with chaste heroines and square-jawed naval officers. Only Bacon could have suggested naming the first British submarines *Discosaurus*, *Piscosaurus*, *Nothosaurus*, *Pleisiosaurus*, *Somosaurus* and – for HM Submarine *A1* – *Ichthyosaurus* (because this boat was "fitted with an optical tube corresponding to the marvellous eye of the reptile, which was two feet in diameter.") See Bacon memo 'Naming submarine boats' 3 July 1902. "The names... suggested by Captain Bacon are rather formidable," shuddered the Senior Naval Lord as he vetoed the suggestion. (Minute of 5 July 1902; both extracts are from Adm 138/180B section 21)

[72] Bacon report 16 January 1904, Adm 1/7719

[73] Hankey to Richmond 18 February 1916, in Marder, *Portrait of an Admiral: the life and papers of Sir Herbert Richmond* (London 1952) p.201; Tyrwhitt to Keyes 29 December 1916, KP 15/23, in Halpern I, 376

Lord Charles Beresford. While in the Mediterranean, Bacon sent Fisher a number of letters that implied criticism of the senior officers on the station, and unbeknown to him the First Sea Lord had them printed for private circulation as part of his campaign against naval 'fossils'. Inevitably the letters got out, in 1909, elevating the author (whose criticisms were judged to have broken the Navy's cardinal rule of discretion) to unprecedented heights of unpopularity [74]. Bacon's subsequent decision to leave the Navy and take up a lucrative post in the arms industry did nothing to restore his honour, and nor did Fisher's 1915 decision to give his protege command of the Dover Patrol over the heads of many officers who had served through the intervening period. During the war, Bacon was faulted for his lack of aggression and refusal to risk his (scarce) resources. Historians too have contributed to the barrage of criticism, recently questioning (perhaps unfairly) his decision, while DNO, to turn down AH Pollen's controversial 'Argo clock' rangefinder when it was offered to the RN [75]. None of these controversies should be allowed to affect the assessment of Bacon's early achievements as ICS, which were very considerable.

To Bacon goes the credit of establishing the semi-autonomous submarine branch and of developing boats that (despite flaws in the A-class design) consistently performed well in peace and war. Equally importantly, his determined caution ensured that the submarine branch was developed along sensible lines. The first ICS was acutely aware of the early shortcomings of underwater craft - quite properly, one feels, given the unknown qualities of the new weapon. "I should particularly emphasise that I do not commend rashness, in fact my life is spent in preaching caution," he wrote in 1904, adding in another paper: "The only fear regarding the safety of the Boats is that familiarity may breed over-confidence." [76] Bacon's philosophy was that "success belongs to the man who pays attention to infinite details." [77]

[74] Bacon letters dated c.12 April 1906 and 15 April 1906 are reprinted in Marder, FG II, pp.72-4, 75-77. See also Fisher to McKenna 5 April 1909, FP 376.

[75] Jon Sumida, *In defence of naval supremacy: finance, technology and British naval policy 1889-1914* (Boston 1989) pp.121, 132-3

[76] Bacon report on training 8 May 1904, Adm 1/7644; Bacon report 31 May 1903, enclosure 1, Adm 1/7725

[77] Bacon report 16 January 1904, Adm 1/7719

There is little doubt that the Inspecting Captain's determination to concentrate on technical matters and on detail did partly close his eyes to the broader picture, inhibiting the development of ambitious strategy and emphasising the shortcomings of the submarine. Bacon's methodical, risk–free approach paid dividends in peacetime, but it would have been limiting in war. Britain was perhaps fortunate that Roger Keyes headed the submarine service in August 1914; certainly he lacked Bacon's gloomy imagination [78].

There is no doubt that Bacon was the most significant figure in the pre–war Submarine Service. He founded it, largely determined its policies, and designed much of the *materiel* with which the British submariner worked. Equally importantly, he chose his own successor, Captain Edgar Lees, and Lees in turn selected Commander Sydney Hall as his relief [79], ensuring a strong measure of continuity [see section 3.2]. Both Hall and Lees served in the submarine branch while Bacon was ICS, and both somewhat resembled him in character. Certainly it was caution – the hallmark of Bacon, Lees and Hall – that dictated the measured technical development of the submarine, and caution which (communicated to the Admiralty via the Inspecting Captains' reports) reinforced the idea that submarines were ideally suited to harbour and coastal defence.

Nor did the first Inspecting Captain's involvement with the Submarine Service end in 1904. In 1905 he conducted the inquiry into the loss of *A8* and advised on the recruitment of officers to the submarine branch. Hall and Fisher were still seeking his opinion as late as 1913 [80].

Captain SS Hall (ICS 1906–1910; Commodore (S) 1915–1919)

Like Bacon, Sydney Hall (1872–1955), the third Inspecting Captain of Submarines, was primarily a technician. An inventor and a torpedo man, he

[78] This difference in approach was perfectly illustrated by the Zeebrugge Raid of April 1918. Bacon, who commanded the Dover Patrol until January 1918, had been planning such an action for some time, but he was fully aware it would most likely be a costly failure. Keyes pressed ahead with a plan which Bacon did not support. The attempt to block the canal entrance predictably failed and cost several hundred lives. The huge boost this dashing assault gave to British morale at a critical time in the war, however, made the attack worthwhile.

[79] Bacon asked for Lees as his assistant in December 1902: 'Appointment of a commander for service in submarine boats' 20 December 1902, Adm 1/7605; 'Appointment of Commander SS Hall' 6 January 1904, digest cut 11a, Adm 12/1402

[80] Cf. 'HM Submarine *A8*' 4 December 1905, Adm 1/7996

understood the intricacies of the submarine far better than his successor, Keyes, who recalled that "the technical knowledge of Brandt and Hall was immense, there was no small detail with which they did not concern themselves." [81] Hall was, in addition, at least as innovative as the first ICS. He designed the first submarine escape helmet, and was also responsible for the D class submarine gun mounting – the plans for which he drew up one Sunday after being told that Vickers had given up the job as too difficult [82].

But SS Hall was more than just a technical specialist. Although undistinguished as a strategist, he had the imagination to recognise before the war that submarines would be used to torpedo merchant vessels, and by 1920 he was prophesying the rise of air power and proclaiming that the battleship was obsolescent [83]. This sort of independent spirit, or refusal to conform, made Hall an ideal man to head the semi–autonomous submarine branch. After the ICS returned from a far from prestigious spell in command of an old second class cruiser in the Mediterranean, Keyes charged that "service in the fleet bores you, and you have never been at any pains to hide this. The *Diana* had a reputation for avoiding rather than conforming to the customs of the service. I know that you think this very petty, but others don't..." [84]

Sydney Hall was offered the Inspecting Captaincy in 1906 at the instigation of his predecessor, Edgar Lees. The second ICS is an insubstantial figure, and the period 1904–1906 remains largely unilluminated by official correspondence or personal papers. Usually characterised as quiet and scholarly, Lees seems to have been too preoccupied with technical matters to give attention to the organisation of personnel. CG Brodie's description of the young service as "a youthful rabble without tradition or leader" belongs to this period; he comments that as a young submariner he never laid eyes on Reginald Bacon, and only once glimpsed Captain Lees in the distance [85]. Hall complained of the "hugger mugger state of

[81] Keyes, NM I, 25

[82] Hall to Keyes 15 December 1912, KP 4/22

[83] Cf. Hall's articles in *The Times*, 10 December 1920 pp.11–12 and 14 December 1920 pp.13–14

[84] Keyes to Hall nd (December 1913), KP 4/22

[85] CG Brodie, 'Some early submariners' part I, *Naval Review* 1962 pp.427–9

the service when I took over" [86], but his opinion of Lees was influenced by disapproval of the latter's design for the C boats and for HM Submarine *D1*. "When I took over from Edgar Lees the C class and *D1* were settled, the only thing I could do with them was to insist on a general smoothening up of the hull and superstructure," he wrote. "I really feel in no way responsible for them, they do... so greatly exceed the capacity of their crew." [87] This was too harsh a judgement (Hall disliked everyone's designs except his own), and Lees deserves particular credit for developing the D class. That he was 'head-hunted' by Vickers in 1906 to run the Whitehead torpedo works at Weymouth is a confirmation of his technical ability, while a stint in the royal yachts during the 1880s indicates early recognition of a social facility and of a promising career [88].

The basis of SS Hall's policy was his attention to the selection of personnel. As ICS he always stressed that the crew of a submarine were far more important than the *materiel*. "There is no vessel," he wrote, "in which the efficiency of the personnel, particularly the officers, bears such a very large proportion to the total efficiency. I have always said that a 2 or 3 knots gain in speed, or any other considerable advance in *materiel*, is not commensurate with the state of the captain's digestion." [89] Emphasis on personnel led Hall to promote the policy of continuity in submarine development and emphasise the value of large classes of identical boats. "I always advised the Admiralty," he wrote in 1911, "that simplicity and a homogeneous lot was in my opinion worth more than any possible gain in *materiel*." [90] In planning for war Hall assumed that a large-scale shuffling of captains and crews would be necessary; it followed that efficiency could best be maintained by ensuring that wherever they went, submarine personnel found themselves serving in familiar craft. Similarly, flotilla-work would be enhanced if all boats performed identically. Hall

[86] Hall to Keyes 7 December 1913, KP 4/22

[87] Hall to Keyes 3 January 1912, ibid

[88] On Lees and Vickers, see section 3.2. On Lees' early career, see 'Appointments to the Royal Yachts' 12 May 1888, Adm 1/6924A. Lees was posted to yachts at the same time as Rosslyn Wemyss, a future First Sea Lord.

[89] Hall to Fisher 17 February 1914, FP 783. This important letter contains a detailed account of Hall's submarine policy.

[90] Hall to Keyes 7 October 1911, KP 4/22

opposed Keyes's 'fleet of samples' and supported the Vickers monopoly for the same reason [91].

The ICS's belief in the importance of personnel had other consequences: the emphasis on training which he promoted meant that in 1914 British submariners were probably more uniformly competent than those of other nations, and it was this aspect of Hall's work that Keyes thought the chief glory of the British submarine service [92]. The same policy left Hall impatient of those junior submarine officers who were more interested in experimenting with *materiel* and who generally supported Keyes: "A constant stream of ideas and inventions and improvements in design continually pours in from the submarine service itself which, unless steadily resisted, involves constant alterations, tests and trials which are a waste of money and time and in my opinion detract from war efficiency," Hall reminded Fisher. "You may remember that there were various types of submarines pushed at me, not only submarines but engines batteries and all parts of submarines which I resisted with all my power because they really do not matter. *To repeat*, given a strong vessel and interchangeability as far as possible, the all-important element is personnel." [93]

Slightly reactionary as these views at first appear, they in fact represent a practical approach to submarine policy. Constant innovation and the temptation to delay while new devices are perfected have long bedevilled weapons procurement in every field, and over-elaborate weapons systems which simply refuse to work in the field are discarded in the course of most campaigns. It is to Hall's credit that this last criticism could hardly be made of his boats in 1914.

Hall's belief in the superiority of British submarine design was however potentially dangerous. Though he turned out to be largely correct in his views, both he and his predecessors were too closely involved with technical development to be objective. It was Keyes the non-specialist's curiosity which led him to experiment abroad, and it was this policy which *proved*

[91] Hall to Fisher 17 February 1914, FP 783. See also Hall to Fisher 3 August 1909, FP 413.

Hall still held the same opinion in 1920 – see his evidence for the Post-war Questions Committee, Adm 116/2060 fols.726-38, esp. fol.730. For Keyes's view, see Keyes to Hall 19 October 1911, KP 4/22.

[92] Keyes to Hall 19 October 1912, KP 4/22; Keyes NM I, 25

[93] Hall to Fisher 17 February 1914, FP 783

Hall to be right. Nor should it be forgotten that the RN had much to learn in some areas, such as that of periscope design.

RJB Keyes (ICS 1910–11; Commodore (S) 1911–1915)

Roger Keyes was not a specialist. He knew little about submarines, although his brother Adrian had served in them in the early days of the service, and he knew his own technical abilities were minimal. But he was a seaman, an enthusiastic extrovert untainted by the disputes which threatened the unity of the pre–war Navy, and therefore just the man the First Sea Lord, AK Wilson, wanted to 'sell' submarines to a still–suspicious Fleet [94].

Keyes was a child when he joined the Navy in 1885, and in many ways he remained a child at heart. His early service smacked of the nineteenth century, not of the twentieth; he was posted to foreign stations and served in colonial wars. His view of the Royal Navy, its traditions and its purpose, were shaped by the stirring pages of *James' naval history* which he had devoured in his youth [95]. "Roger does not read very much," wrote his friend, the businessman and amateur conservative politician FS Oliver, "but one thing he does read, which seems to have gone right to his spirit – the doings of Elizabethan sailors." [96]

The most obvious point to make about Keyes is that he possessed 'offensive spirit' in abundance, and thus embraced a great British naval ideal. Bacon and Hall thought problems through, weighed risks and sometimes counselled inaction where Keyes, spurred on by his own conception of naval tradition, would have rushed in headlong.

Keyes's self–confidence, and also his undoubted bravery, stemmed from a belief in 'joss', or luck, acquired on active service in China during the Boxer Rebellion. "I am an absolute fatalist and have the greatest faith in my good luck – so am content to sit quiet and good until whatever is

[94] Keyes NM I, 23–4

[95] Cf. Keyes to his wife 11 December 1914, KP 2/5

[96] FS Oliver to his brother 16 May 1918, in Stephen Gwynn (ed), *The anvil of war: letters between FS Oliver and his brother 1914–1918* (London 1936) p.320

'written' comes along," he told Walter Cowan [97]. The submariner CG Brodie got to know Keyes well during the Great War and sums up his character perfectly: "Courting danger, and exhilarated by it, Keyes's ardour seemed natural to him, but it must have been partly self–taught. In the small cabin where I best knew him, Kipling's *If* was above his wash basin. He told me he read it every morning, and that simple avowal made me ashamed of my own self–conscious reservations about that bracing poem. Victorian virtues are useful in wartime; Keyes was fearless and made others forget their fears." [98]

Keyes's fearlessness found an outlet in the Great War. Writing to Doveton Sturdee upon the outbreak of hostilities, he declared: "I have dreamt of, and lived for, real war ever since that mild bickering I was fortunate enough to see in China... These last three years I have been trying to train the submarines for war, and war only..." [99] In the belief that *Britain had to seize the physical and psychological initiative*, he was (with Commodore Tyrwhitt) directly responsible for initiating events which led to the Battle of the Heligoland Bight (28 August 1914), sending submarines and a light surface screen to reconnoitre German coastal waters [see section 8.1]. The battle that ensued bore all the hallmarks of a Keyes action. Although dashing and aggressive, the operation was poorly planned and co–ordinated. Without the timely appearance of Beatty's battle–cruisers (of whose presence they were unaware), the two Commodores could easily have been responsible for a disaster [100]. But then Keyes firmly believed that sailors could do the impossible if well enough led [101] – a belief he maintained through the Gallipoli campaign to Zeebrugge.

When war was declared the Commodore had to be formally cautioned not to expose himself to risk [102], and soon he found the sailor's enforced

[97] Keyes to Cowan 11 June 1917, Cowan Mss. COW/6, National Maritime Museum, in Halpern I, 398–9

[98] CG Brodie, *Forlorn hope 1915: the submarine passage of the Dardanelles* (London 1956) p.44

[99] Keyes to Sturdee (*Chief of the War Staff*) 21 August 1914, KP 4/34

[100] On the Battle of Heligoland Bight, see Keyes diary c.28 August 1914, KP 2/6; Marder, DSF II, 50–5

[101] Brodie op.cit. p.44

[102] Keyes to Jellicoe 4 August 1914, KP 4/30

inactivity such a burden that he wrote: "I think next time I come into this world I shall be a soldier – it was stupid of me not to have thought of it before making up one's mind to go into the Navy. History is quite clear on the subject. Soldiers fight almost every day of a war. Sailors about once a year at the most if they are lucky." [103] Here was the root of Keyes's personality, and of his popularity. He struck a deep chord in the traditional hearts that most sailors still possessed, and it was one which Hall and Bacon could never play. Submarine history has been 'pro–Keyes' ever since.

Unlike Hall, whose 1920 decision to retire was based on a refusal to return to sea in the belief his career would advance no further [104], Keyes loathed dealing with the Admiralty and pined for active service. In August 1914 he had been due to join the battlecruiser fleet as captain of the brand–new HMS *Tiger*, but the outbreak of war kept him with the submarine branch. Trying to make up for his disappointment, he went to sea as often as he could, and though the Commodoreship was supposed to be a desk job, the *Official History* noted that "under Commodore Keyes it tended to become an active command." [105]

Roger Keyes had an open personality and made friends – particularly powerful friends – with ease; his extensive network of acquaintances, especially among naval 'salt horses', saved him from reprimands for disobedience and insubordination on occasion, and it was this ability to move in what might be termed the 'traditional', sea–going circles of the RN that Wilson wanted to tap. Early in his career Keyes had served in China with Jellicoe, Field, Warrender, Colville, Callaghan and his long–time lieutenant, Wilfred Tomkinson. Winning early promotion for exploits such as the cutting out of six Chinese destroyers above the Taku Forts, he commanded a TBD flotilla in the Channel and befriended the influential Admiral Noel, then served several years as naval attache to Italy and Austria and two as captain of a second–class cruiser before being appointed to the Submarine Service. The new ICS also fell in with the Navy's fox–hunting set – men such as Beatty, Cowan and de Robeck with

[103] Keyes to his wife 11 December 1914, KP 2/5

[104] Waistell to Keyes 15 September 1915, KP 4/40; Keyes to Brock 13 January 1921, KP 8/1, in Halpern II, 49

[105] Julian Corbett and Sir Henry Newbolt, *Official history of the war: Naval operations* (5 vols, London 1920–31) I, 16n

whom he was to work closely during the war [106]. Through his family he was acquainted with many army officers; his father, for example, had once saved the life of the young Ian Hamilton, while Braithwaite, another Dardanelles general, was an old friend.

But Keyes's most important ally was the pugnacious Churchill, who described the Commodore as "a brilliant officer, with more knowledge and feeling for war than almost any naval officer I have met" [107], and lent him the support he needed to resist Fisher's determination to return Hall to the submarine service. The First Sea Lord held a low opinion of the Commodore (S), and Keyes confessed himself "disgusted at the old villain's ruthless pursuit of me." [108] (This, for him, was strong language.) Fisher's antipathy had two roots. He had, firstly, once confused Keyes with John Keys, Lord Beresford's secretary, who had been trying to get pro-Beresford marterial published in *The Times*. (The Commodore had actually maintained strict neutrality in the dispute, but by this time Fisher was convinced that anyone who was not for him had to be against him.) More importantly, Hall had convinced the Admiral that Keyes's submarine policy was dangerous and (particularly) that it was a negation of Fisher's own work in the field. We shall come to Fisher's contribution to submarine development in section 5.1; suffice it to say here that his opinions were contradictory and somewhat unfair to Keyes. Since Keyes did not join the submarine service until after Fisher retired in 1910, the Admiral's antipathy was of little note until 1914, but his enmity and the methods he chose to employ in removing Keyes were then largely responsible for the considerable acrimony which attended Hall's return at the end of the year [109].

Much of the anguish felt by Keyes's friends [110] was due to genuine

[106] Keyes NM I, 45–7

[107] Churchill to Fisher 24 December 1914, FP 870. See also Marder, FG III pp.105, 109

[108] Keyes to his wife 3 February 1915, KP 2/8

[109] On Fisher's relations with Keyes, see Keyes diary 28 October 1914, KP 2/6; Keyes to his wife 31 October, KP 2/3, 8 November KP 2/4, and 22 December 1914 KP 2/5; Keyes to Addison 22 May 1917, Addison papers, Royal Navy Submarine Museum A1986/77; Halpern I, 50–1; Keyes NM I, pp.20–1, 53–5; Mackay op.cit. pp.454–5, 465

[110] See eg Addison to Keyes 7 November 1914, KP 4/41; Tomkinson to Keyes 1 May 1915, ibid; Tomkinson war diary entries for 4, 7 and 18 November 1914 and 3 February 1915, Tomkinson papers TOMK 2/1, Churchill College Cambridge

revulsion for Fisher's methods. "It is perfectly disgusting and contemptible the way that JF and his accomplices have got rid of Keyes and Addison, and made it look as if they were being shot out for mismanagement after all the good work they have done the last four years or so," wrote Tomkinson in his diary, "perfectly iniquitous I call it, and I hear that it has been handed round in the clubs &c. that this is the reason they are leaving. There is no end to the meanness and blackguardisms of that crowd..." [111] But Keyes's advisors also realised that Hall distrusted them and blamed them for the policy of experimentation with foreign designs. They were the officers who had pestered Hall with suggestions and inventions, and to whom he referred when he told Fisher that "there is in submarine work a strong tendency to attach a great deal of importance to *materiel*; it is particularly evident in the younger officers of average capacity or below it, and in those who do not have to look outside any one submarine or flotilla of submarines..." [112] These men feared a return to the paternalistic system of leadership which the old ICS had practised, and which would inevitably lead to the curtailment of the freedom of action they had enjoyed under Keyes. Most of all, they resented the thought that their own influence upon submarine policy would soon be history.

The junior officers of the submarine branch played a much more significant role in determining policy under Keyes than they had ever done under Bacon or Hall. Unlike his predecessors, whose self-confidence sometimes bordered on arrogance, Keyes was always troubled by a supposed lack of intellect - "I am so very conscious of being thick-headed," he told Beatty [113]. Jellicoe thought that "Keyes is a fine fellow but is not blessed with much brains" [114], Fisher that he was "very shallow" [115]. In fact the Commodore was probably of no less than average intelligence and was, rather, burdened with poor powers of expression - "most inconsequent or irrelevant, jumping backwards and forwards without any regard for logical order, which I daresay produces the impression on a

[111] Tomkinson war diary 9 February 1915, TOMK 2/1.

[112] Hall to Fisher 17 February 1914, FP 783

[113] Keyes to Beatty 19 February 1918, Beatty Mss., in Halpern I, 457

[114] Jellicoe to Hamilton 9 November 1915, Hamilton Mss., in AT Patterson (ed.) *The Jellicoe papers: selections from the private and official correspondence of Admiral of the Fleet Earl Jellicoe of Scapa* (London 1966) I, 187

[115] Fisher to Jellicoe 4 April 1915, quoted in Marder, FG III, 186

particularly tidy, finicky mind that Roger's mind must be a disorganised chaos," wrote FS Oliver. Keyes, Oliver thought, saw the solutions to problems in "an intense vision", and his "mental vistas" were "quite untrammelled by the immense mass of minor business" which so preoccupied Bacon, Lees and Hall [116]. But this vision, though intense, was nebulous. The Commodore saw an ideal outcome, not a precise plan, and that is why he needed a good staff [117].

One of Keyes's first decisions upon taking command of the Submarine Service in 1910 was to appoint a committee of six junior officers to advise him on technical problems. He was indubitably eager to make full use of the brains of his subordinates and took them into his confidence, thus circumventing his most serious shortcoming. Moreover Keyes showed himself a fair judge of character. All six submarine officers on the committee enjoyed distinguished careers [118].

The Commodore's most trusted advisors were Percy Addison, who supervised and directed technical development, and later Arthur Waistell, to whom he turned for help in drafting reports and memoranda. It was to these men that Keyes 'willed' the submarine service in the event of his death [119]. Given his acknowledged technological illiteracy, it would not be rash to suggest that Keyes's construction policy was really Addison's, and that the latter – a man whom Keyes described as "a most zealous officer of exceptional ability" – was almost as important a figure as his commanding officer [120]. Certainly it was Addision who bore the brunt of Hall's wrath at Keyes's submarine policy and who left the submarine branch because he found it impossible to work in the same office as Fisher's

[116] FS Oliver to his brother 25 May 1918, in Gwynn op.cit. pp.332–4

[117] Keyes never denied that his staff work was poor. CG Brodie recalled that when Keyes was Chief of Staff to the British naval forces off Gallipoli, "an experienced assistant could have spared him much of the [routine work], but I started very green. Several times during the first hectic days he told me, 'You are the worst staff officer in the world.' This was painfully true, but if he thought it had hurt, he would add, 'except me', which was not entirely wrong, either..." Brodie op.cit. p.3

[118] Cf. William Jameson, *The fleet that Jack built: nine men who made a modern navy* (London 1962) p.295.

[119] Keyes to Sturdee 5 August 1914, Adm 137/2067 fol.603. On Addison, see Keyes diary 28 October 1914, KP 2/6, and Addison to Keyes 7 November 1914, KP 4/41. On Waistell, cf Keyes to Sturdee 1 November 1914, KP 4/34; Tomkinson to Keyes 1 May 1915, KP 4/41.

[120] Keyes report on Addison 30 August 1912, Addison papers, Royal Navy Submarine Museum A1986/77

appointee [121].

The poisonous atmosphere created by the Hall/Keyes dispute could have jeopardised the efficiency of the submarine branch, and it was fortunate indeed that both men respected the sincerity with which the other held his views, and found that *in extremis* they were capable of "working together for the confusion of the enemy – which is the only thing that matters." [122] But privately their criticisms of each other were harsh [123], and from 1910 the Trade experienced a little of the atmosphere that bedevilled the French submarine service in the pre–war period.

Hall himself remained convinced the Trade's problems in 1914 were "entirely due to the Authorities having thought that the time had arrived for taking the submarine business out of the hands of specialists – *and it had not!*" [124] Certainly it might have been better for the RN if construction had continued upon the lines laid down by Hall and his predecessors – but as was suggested above, there was little proof at the time that this was the case. Equally, Keyes's greatest achievement was certainly to promote integration with the fleet – which eventually led to acceptance of the submarine as a valuable weapon, and caused him to oppose Hall's return on the grounds that "although the submarine service owes you a great debt in regard to its early development, you have not made good a claim, which you might well have done, to come back to command what has become very much a recognised part of the seagoing fleet." [125] But the policy enjoyed only limited success in the short term, since familiarisation was not the same thing as integration, and the process was not sufficiently advanced in 1914 for the majority of officers to recognise the new threat they faced. The strategic implications of the submarine were in consequence far from fully worked out. Bacon, Lees, Hall and Keyes had fashioned a formidable new naval arm which only they properly appreciated and understood. They did what was expected of

[121] Keyes to his wife 12 November 1914, KP 2/4. See also Hall to Keyes 1 December 1913, KP 4/22

[122] Keyes to Hall 20 January 1915, KP 4/27

[123] Keyes thought Hall "was the man whose short–sightedness and narrow–mindedness was responsible for our poor position in regard to submarine construction." (Diary 28 October 1914, KP 2/6) Hall wrote that "it is tragic that our Vote for submarines should be frittered away on 'freaks and coastals'." (Hall to Fisher 26 April 1914, FP 803)

[124] Hall to Fisher 26 April 1914, FP 803

[125] Keyes to Hall nd (December 1913) KP 4/22

captains and commodores; the problem of assessment was the province of admirals and Admiralty.

The problem of assessment

Naval factions and the submarine

In the early years of the twentieth century, the Royal Navy employed tens of thousands of officers and men. From its ranks came professors and poets, world–famous novelists, kings, gods and even Field Marshals; collectively, these men expressed an astonishing variety of opinions. The surprising thing about British assessment of the submarine is not that the new weapon created controversy – though it did – but that the debate was as muted as it was poorly informed.

Three factors combined to prevent accurate evaluation of the submarine before 1914: naval factionalism, prejudice and ignorance. Of these, ignorance of the precise capabilities of underwater craft – one of the major themes of this thesis – was the most important, since it fuelled prejudice and permitted factionalism to flourish. Before 1914 the submarine was quite untested. It had not seen action for 50 years, and there was no telling what it was capable of and what it might or might not do. Optimists, particularly Fisher, predicted it would displace the Dreadnought. Sceptics, including Admiral Sir Reginald Custance, a former DNI, disagreed: "The submarine may have some value," the latter concluded, "but they are too untried in war to make it safe to place exclusive reliance on them. The war efficiency of these vessels is liable to be over–rated." [1]

[1] 'Notes by Sir Reginald Custance' 30 August 1913, Adm 116/3381

The dispute between Fisher and Custance was a dispute between naval factions [see also sections 1.4 and 6.1]. Although submarines had been introduced before Fisher became First Sea Lord, they became intimately associated with his 1904–1910 regime, and officers who opposed Fisher were likely to oppose the submarine also. Many were offended as much by the tactless bludgeoning tactics and open favouritism displayed by the new administration as they were by Fisher's innovations, but men who thought the First Sea Lord was compromising national security by scrapping warships and building Dreadnoughts saw the submarine as a symbol of what they considered to be the abandonment of traditional British strategy.

The discontent that Fisher aroused came close to splitting the Navy in the latter years of his term as First Sea Lord. It resulted in a more or less open dispute with Lord Charles Beresford, which eventually threatened the efficiency of the RN itself [2], and was compounded by an equally serious struggle between the 'Blue Water' school of navalists and those who demanded the strengthening of Britain's land defences to combat the possibility of invasion [3]. The First Sea Lord's enemies included many naval traditionalists, pressure groups such as the Imperial Maritime League, and a substantial portion of the press; Fisher himself added greatly to their numbers by impulsively but consistently branding those who disagreed with him as enemies. Under his leadership, the united front presented by the Navy to the public (which had long been one of the service's most impressive assets) was badly fragmented. The submarine became a pawn in the greater controversies that engulfed the administration.

The early boats, with their comparatively puny offensive capability, simply did not complement the existing conception of the Royal Navy as an instrument for all–out attack. "They are being exploited along entirely the wrong lines," observed Beresford's colleague Custance. "My view is that if a weapon of this sort is developed with an eye for its use in offensive warfare, its use in the defensive will be covered, but that the reverse does not hold." 'Charlie B.' encountered Hall's flotillas in the manouevres of 1908, which "were really planned to show the utility of sub–marines." He

[2] Ruddock Mackay, *Fisher of Kilverstone* (Oxford 1973) pp.361–6, 394–7, 400–03, 412–17

[3] Ibid pp.381–6, 392–8

was sure "we have deserted the only true and traditional policy of the British – i.e. to find out the enemy in Blue Water and destroy him, and the General has been informed that the submarines will prevent invasion and put down any enemy *even in their own ports*. Total falsity. Sub–marines were within 120 miles of me for three days and did nothing." [4] Beresford called them 'Fisher's playthings', and even in 1914 could remark that the submarine was an essentially defensive weapon which could not defend herself, best operated by day in clear weather [5].

The association of the submarine with Fisher and the reformist regime was strengthened by the First Sea Lord's relationships with the influential Inspecting Captains Bacon and Hall. Bacon was, as we have seen, always regarded as a protege of Fisher's, and although the evidence suggests that the Sea Lord learned his enthusiasm for the submarine from Bacon, rather than the other way around [6], the association, and Bacon's later fall from grace, did much to taint the reputation of the Submarine Service. The objects of Fisher's violent enthusiasms often elicited a degree of distaste from naval officers, and as SS Hall remarked to Keyes, "the awful stigma attaching to a creation of Fisher and Bacon must necessarily have taken years to remove." [7]

Hall, a more junior officer than Bacon, was just as strong a swimmer in the 'Fishpond' [8]. He owed the Secretaryship of the 1913 Royal Commission on Oil Fuels (and a CB) to Fisher's patronage, and was appointed to command the Submarine Service during the war almost

[4] Custance to Bridge 1 September 1904, Bridge papers BRI 18 (file 3), National Maritime Museum; Beresford to Noel 9 February 1909, Noel papers NOE 5, 'Correspondence with important persons', National Maritime Museum.

[5] Beresford's address to the Institution of Naval Architects, July 1914, TrINA LVI pp.268–70; 'Playthings' quote referred to by Fisher in a letter to Balfour, 11 May 1913, Balfour papers Add.Mss. 49712 fol.93

[6] It has often been supposed that Fisher exercised considerable influence over Bacon, and thus directed the course of British submarine development. In fact little evidence can be produced to support such an assertion. Bacon did not come fully under Fisher's spell until 1904, when both men were serving at Portsmouth – and by then the younger man had already been ICS for nearly three years. There is no correspondence in the First Sea Lord's papers to suggest a significant collaboration before that year. Fisher's previous appointments as CinC Mediterranean and Second Sea Lord did not involve him in a close study of the submarine, and it must be supposed that he learned his enthusiasm for the weapon from Bacon rather than *vice versa*.

[7] Hall to Keyes 7 December 1913, Keyes papers KP 4/22, British Library

[8] A contemporary term for the group of officers who enjoyed Fisher's patronage, similar in influence to the 'bunch of keys' favoured by the nineteenth century Sea Lord Sir Cooper Key.

immediately after Fisher's return to the Admiralty. Many of the First Sea Lord's opponents saw Hall (unfairly) as little more than a puppet [9]. In exchange for his support, Hall kept Fisher supplied with information and advice after the latter's retirement in 1910. Nor was he averse to appealing to Fisher's influence when he disapproved of Keyes's policies [10].

Though he owed much to Fisher, Hall knew that the Sea Lord's increasingly autocratic style of leadership was causing concern in many quarters and was anxious to eschew the taint of partisanship. Fisher was a "dangerous friend", and at one point Hall was forced to ask for "a promise from JF not to canvass me for any more jobs!" [11] He once told Keyes that Fisher's overt backing made him "feel like a 'pariah'" among his brother officers [12].

The First Sea Lord was undoubtedly among the most vociferous supporters of submarine warfare. Without the powerful influence he wielded, it is not impossible that the British submarine would have evolved differently, and quite likely that it would not have been built in the quantities that it was and – most significantly – adapted to the coastal defence role it fulfilled. But Fisher could not could not resist weaving underwater craft into his wilder flights of fancy and incorporating them into schemes that did them no credit. Hall captured this dichotomy when he wrote, "I forgive him his unbounded interest in the submarine service because he nurtured it in the teeth of great opposition." [13]

The submarine boat became a stick with which mostly retired officers could beat the Fisher administration. "Submarines (pushed by Fisher) the arm of the weak navy are being turned upon us with disastrous results," charged Admiral Noel during the Great War. "Their introduction alone is enough to condemn the Naval Administration of that time." [14]

Underwater craft were as much a symbol of change as they were a

[9] Keyes diary 26 October 1914, KP 2/6

[10] Cf Hall to Fisher 17 February 1914, Fisher papers FP 783, Churchill College Cambridge

[11] Hall to Keyes c.23 February 1914, KP 4/22; Hall to Keyes 22 June 1913, ibid. See also Hall to Keyes, nd (December 1913), ibid

[12] Quoted in Keyes to Hall nd (December 1913), ibid

[13] Hall to Keyes, nd (December 1913), ibid

[14] Noel to Redesdale 28 April ?1915, Noel papers NOE 5, 'Correspondence on naval matters 1904–1917'

weapon in Fisher's eyes, and he presented himself as the prophet and architect of that change. That is why the Sea Lord's opponents were anxious to decry submarine warfare. The naval 'conservatives' who broadly refused to believe in the new weapon were not simply thick–headed reactionaries, and they did not deny that the submarine would become a powerful weapon – merely stressing that it would take a considerable time to perfect. Officers such as Custance and Beresford should no more be blamed for looking to the past for unsound guidance than Fisher and like–minded 'progressives' should be praised for casting their imaginations unsupported into the future. It was both parties' tendency to reduce the submarine to little more than a footnote in a great naval debate that really hindered serious consideration of the weapon.

Piracy and prejudice

It was in France, late in the eighteenth century, that the idea submarine warfare was morally repugnant first established itself and Fulton's 1797 submission to the Directory was rejected by the aged naval minister, Pleville–le–Pelley, on the grounds that submarines could not conform to the rules of war [15].

There has always been something diabolical about underwater weapons. In the nineteenth and early twentieth centuries, mines (known for years as 'infernal machines'), torpedoes and submarines represented the unknown; devastating, invisible, difficult to resist and impossible to avoid, they evoked distrust and distaste in roughly equal measures. In 1900 many British naval officers would probably have agreed that the Royal Navy and the world would be better off without them. But most seamen are pragmatists; there is not a single document among the Admiralty papers to suggest that its submarine policy was ever affected by moral revulsion, and much negative evidence to suggest that it was not.

We have seen that the submarine was adopted by the Royal Navy as

[15] Wallace Hutcheon, *Robert Fulton and naval warfare* (unpublished PhD thesis, George Washington University 1975) p.47

the result of an unprejudiced assessement, that it was by and large sensibly developed, and that submariners themselves were practically a protected species. By 1914, moreover, the British submarine service was easily the largest in the world. The RN might have been guilty of failing to exploit the full potential of the weapon, but it never actively retarded its development.

At least part of the notorious naval 'prejudice' against submarines had nothing to do with the submarine itself. The behaviour of some young submariners could almost have been calculated to irk their superiors, who resented being asked to put themselves out of action, during manoeuvres, by submarines "loafing around the North Sea mopping up anything that comes ...[their]... way" [16]. Nor were the pioneer submariners noticeably more restrained on land, where Max Horton (arguably the most successful British submarine commander of the Great War) was described as "a desperate motorcyclist" and EC Boyle charged with "riding a motor bicycle at a speed dangerous to the public" after knocking down a teenaged girl. (He was fined £5 plus costs, which his fellow submariner Talbot considered "pretty excessive".) Keyes remembered that Lieutenant Norman Holbrook (the first submariner VC) "used to drive rather furiously – and was the man who ran into Captain Nicholson with, the latter said, a car full of lovely joy riders." He was "rather the same type as Horton – a bit of a swashbuckler." [17]

Submariners had their own peculiar dress code. Grimy officers were labelled "unwashed chauffeurs" by their cleaner battlefleet brethren [18], and one young CO admitted that after five days at sea he and his crew looked "a pretty filthy lot of pirates" [19]. Even the more senior submariners were inclined to let their standards slip; Lieutenant–Commander Herbert Shove was noted for his "matted, dishevelled hair and a high watermark above his collar", and kept a pet rat up one sleeve of his monkey jacket [20]. On

[16] Hall to Fisher nd (1913), FP 648

[17] Hall report on Horton October 1907, quoted in WS Chalmers, *Max Horton and the western approaches* (London 1954) p.4; Talbot diary 16 May 1905, Talbot papers 81/42/2, Imperial War Museum; Keyes to his wife 14 and 15 December 1914, KP 2/5

[18] Richard Compton–Hall, *Submarine boats: the beginnings of underwater warfare* (London 1983) p.19

[19] Talbot diary 16 June 1906, Talbot papers 81/42/3

[20] Richard Compton–Hall, *Submarine warfare: monsters and midgets* (Poole 1985) p.20

one notable occasion Commander Frank Brandt, Hall's second–in–command, was surprised by a visit from the Admiral Commanding Devonport Dockyard, and "summoned hastily from below, [he] met his admiral at the top of the gangway in carpet slippers, his trousers turned up, and his unbuttoned monkey jacket displaying to the scandalised eye of the flag officer a vast expanse of pink flannel shirt." [21] As Richard Compton–Hall concedes, "some of the first submariners were thought a little strange, even at the time, but this is not surprising. They had, after all, sacrificed a far more secure career in the surface fleet, and a proportion of them were bound to be refugees from the glitter, gunnery and gaiters... Responsibility and risk were counted far more highly and they attracted some unusual and colourful characters." [22]

In a navy that encouraged the growth of tight–knit groups which might become cliques, pride and prejudice were commonplace. The torpedo service in general was looked down on by the battleship navy; the quarter deck sneered at engineers and doubted the usefulness of aircraft. But – at least in the case of submarines – such feelings were not wholly destructive. They were warmly reciprocated by the submariners themselves, who thereby strengthened their own sense of identity, just as the destroyer crew described as "decent enough chaps, but socially quite impossible" gloried thereafter in being referred to as SQIs [23]. British submariners revelled in their piratical reputation, and this is surely an indication that it was not one that did them much harm.

Most naval officers, it seems safe to assume, were 'cautious or muddled progressives' in the late pre–war period – ignorant of the submarine's true capabilities, perhaps, but certain that it was a weapon of some power and potential [24]. The majority of them would rarely if ever have encountered underwater craft at sea, and they probably gave comparatively

[21] Charles Kerr, *All in the day's work* (London 1939) p.123

[22] Compton–Hall, *Submarine boats* p.143

[23] Ibid p.185.
Many tales of anti–submarine prejudice have a polished quality which suggests that they may entertain better than they inform. Take for example one story told by Charles Little, who related that on joining *D1* in 1908 he was warned that no service club would accept him as a member (*Mariner's Mirror* 62 (1976) p.199). By that time Little had already served four years in submarines; one wonders why the 'warning' was not given earlier. See also Fisher to Churchill 30 December 1911 in Randolph Churchill and Martin Gilbert, *Winston Spencer Churchill* Companion II pp.1364–5.

[24] Cf Tim Travers, *The killing ground: the British army, the Western Front and the emergence of modern warfare 1900–1918* (London 1987) p.64, where much the same thing is said of army officers and the machine gun.

little real consideration to the submarine, but a number of high–ranking officers who saw the weapon in action did become enthusiasts. Admiral Sir William May criticised Custance's conservative views and observed, "Sir R.C. in my opinion underrates submarines altogether." [25] By 1904 he had concluded that "in a few years when we come to sea–going vessels, *there will be a real revolution in naval warfare*" [26]. George Callaghan, who was in command of the Grand Fleet on the outbreak of war, was sufficiently perturbed by the performance of underwater craft in the 1912 and 1913 manoeuvres to write a paper on anti–submarine warfare, concluding that "the value of the submarine as a weapon, both of offence and defence, is enormous." [27] In 1914 one of the Navy's greatest gunnery experts, Percy Scott, caused a furore by declaring that battleships had been rendered obsolete by submarines and aircraft [see section 6.1].

Callaghan and his successor, Jellicoe, were assessing relatively advanced submarines, but their positive opinion of the boats' capabilities had no more effect on the development of pre–war British naval policy than the more critical evaluations of Fisher's opponents. Britain had been forced to adopt the submarine by the activities of foreign powers; the design that the RN acquired from America largely determined the direction taken by a technical evolution that itself had an appreciable influence on policy. The immutable tenets of Imperial strategy were equally significant, and the semi–autonomy of the Submarine Service made it almost immune to external pressures, particularly from retired officers such as Beresford, Custance and Noel. In some circumstances, such as those that permitted the submarine to put in respectable performances in the manoeuvres of 1912 and 1913, senior officers could have a peripheral impact, but even a man like Fisher failed to wield direct and prolonged influence over submarine policy.

Fear of discrimination was, therefore, a more significant problem than *discrimination itself. Many ambitious officers were reluctant to join a branch* that was reputed to prejudice one's prospects of promotion. In 1905 Edgar Lees noted that submarines were not considered 'good service', and five years later SS Hall observed, "there is certainly an impression amongst

[25] May comments on 'Notes by Sir Reginald Custance' August 1913, Adm 116/3381

[26] May to Fisher 3 January 1904, in Balfour papers Add.Mss. 49710 fol.78

[27] Callaghan paper 'Remarks on North Sea strategy' 28 August 1914, fol.24, Adm 116/3130

younger officers that once they come into submarines they give up all chances of the higher ranks of the service even if they ever get promoted at all. There have I know been many cases where captains have told young officers wishing to volunteer that they were making a great mistake and jeopardising their career." At the time, the question of advancement was still a hypothetical one since few of the junior officers recruited to the Trade had actually served long enough to qualify for promotion. Rumours flourished in this limbo of uncertainty, and Hall suggested that "if a definite number of promotions were given for a batch or two of submarine officers, I mean those who have specialised in it, the volunteering would probably improve." [28]

In this context, it is interesting to compare the pre–war Submarine Service with the post–war Fleet Air Arm [29]. The FAA was a specialist branch officered by volunteers who received bonus payments – 30s. a week flying pay in the 1920s – and served four–year tours interspersed with two years' General Service. There was a shortage of suitable recruits, and it was impossible to maintain the desired reserve of officers. So serious did this problem become that the FAA was forced (from 1938) to accept short–service commissioned officers who had little or no general naval experience.

Like the submarine branch, the Air Arm was in an anomalous position. Dual control was exercised by the Royal Navy and the RAF, and many naval officers doubted the loyalties of FAA fliers. This was a disincentive to men who had chosen to make the Navy their career, and one officer recalled that "those of us who might have had inclinations to fly carefully suppressed their feelings in order not to appear disloyal to their service." [30] Senior officers deplored the way that Air Arm men disappeared into the maw of the RAF every time their ships entered port, and prospective fliers (like submariners) were often warned that they risked ruining their careers by transferring to the new branch.

The problems thrown up by dual control contributed much to the Air

[28] Lees report 'Modifying the system for selecting officers for the submarine service' 2 August 1905, Adm 1/7795; Hall report 12 May 1910, Adm 116/1122. Similar feelings were expressed in the young Royal Naval Air Service – see Sueter memo 'Proposals for special letter in Navy List for air officers' 6 August 1913, Adm 1/8332

[29] The following passage on the Fleet Air Arm is based chiefly on Geoffrey Till, *Air power and the Royal Navy 1914–1945* (London 1979)

[30] Ibid p.45

Arm's inefficiency in the early years of World War II, and had an especially unfortunate effect on the quality of naval aircraft. The FAA's difficulties only emphasise the extreme good fortune of the early twentieth century Submarine Service, cocooned in its cheerful semi–autonomy and free to experiment with *materiel* and develop its unique spirit well away from the disputes thrown up by inter–service bickering.

About 70% of FAA pilots were supplied by the RAF, and the Navy men who joined the branch were rather a mixed bunch. Murray Sueter, a former submariner appointed Director of the RN Air Division, admitted that the wartime Royal Naval Air Service attracted unconventional officers who irritated the more orthodox sea–dogs [31], and in February 1938 Lieutenant Commander Rundell of the aircraft carrier *Furious* awaited his first sight of a new batch of Air Branch officers "prepared for any eventuality from a Dartmoor convict to a Senior Wrangler." [32] In fact the educational attainments of the average FAA recruit were considerably lower than those of aspiring submariners; the Air Arm had the lowest standards of any specialist branch. Many recruits were embarking upon a second career, having been passed over for promotion elsewhere; Keyes himself referred to FAA pilots as mere "engine drivers – it was a necessary job to have filled, but not requiring very high mental attainments." [33] This scathing indictiment was somewhat unfair, for like submariners, Air Arm men were distinguished by a dedication to and enthusiasm for their particular trade.

The Navy proved tolerant of the FAA. There is little evidence that prejudice blighted the careers of naval airmen; indeed one pioneer flier, Caspar John, eventually became First Sea Lord. Powerful sceptics such as as Admirals Sir Dudley Pound and Charles Madden were at worst only intermittently obstructive, and in general there is no evidence that members of either the Air Arm or the Submarine Service were at a disadvantage when it came to promotion. The truth was that in a closed service, advancement was bound to reflect the growth of the service itself, and that at times of rapid development prospects could be good, particularly for the men. In 1906 Captain William Hall observed that the chances of promotion within the submarine service were not so bleak as had been supposed, and

[31] Ibid p.112

[32] Ibid p.56

[33] Ibid pp.47–8. Keyes's paper was dated December 1926.

that all men who had joined as Leading Seamen could expect their Petty Officer rating in due course, thus allowing all but a small percentage of ABs advancement as well. Seven years later an M–branch study showed that promotions within the Trade were actually running at double the normal rate for all ratings except Leading Stokers [34]. Only when officers and men reached the more senior ranks was there a problem; the Trade was simply too small to have more than a few vacancies for warrant officers or men above the rank of lieutenant–commander [35].

A shortage of skilled manpower, which as we have seen caused problems for the Submarine Service, also led the naval authorities to introduce measures intended to boost recruitment of officers and men to another sometimes–despised branch of the service – the engineers [36]. Like submariners, qualified and capable engineers were hard to come by in the late nineteenth and early twentieth centuries. But while the creation of a submarine service hardly threatened the position of executive officers in the big–ship navy, the advent of a class of naval engineers did, and prejudice against men of the engineering branch was both more deeply rooted and more widespread than dislike of submariners.

Recent studies of both the British and the American navies [37] have suggested that deck officers of both services were reluctant to grant engineers equality of status with the military branch not simply because they felt such men were neither fully professional nor their social equals [38], but also because the creation of engineer officers and a steam–powered navy threatened the position of men trained to sail. Conflict between the

[34] Captain William Hall's notes to the revised 'Memoranda relative to service in submarines...' 6 November 1906, Adm 1/7880; M–branch paper 9 June 1913, Adm 116/1122. In the Fleet, only 5.4% of ABs were promoted annually; in the submarine branch the figure was 13.1%. For Leading Seamen the respective figures were 13.5% and 22.5%. These statistics certainly reflect the rapid expansion of the submarine service as much as they do the high quality of the men in it.

[35] Admiralty paper 'Service in submarines' ?September 1913, Adm 116/1122

[36] Christopher Bartlett, *Great Britain and sea power 1815–1853* (Oxford 1963) pp.320–2; Geoffrey Penn, *Up funnel, down screw! The story of the naval engineer* (London 1955) pp.125–6

[37] The problem was certainly not confined to these two services – in 1912 the British attache reported mistreatment of engineers in the German navy was "real and unpleasant... in the shape of a policy of pin–pricks and of aloofness; greater than ever was the case in other navies..." Report dated 16 July 1912 in 'Naval attache's reports, Berlin 1906–1914', Naval Library, Ministry of Defence, Ca.2053

[38] Lance Buhl, 'Mariners and machines: resistance to technological change in the American Navy, 1865–1869', *Journal of American History* 1974 pp.714–15, 717

two branches was particularly severe in the post–Civil War USN, which was run down so rapidly that every executive officer feared for his job and his chances of promotion. Engineers demanding equal rank and status thus threatened to further crowd a navy that offered increasingly little chance of rewarding service [39]. Similarly, the executive branch of the Royal Navy opposed Fisher's 1902 reform scheme – which proposed to allow engineer officers the opportunity to attain flag rank and command warships – chiefly because they doubted that mere 'mechanics' could ever understand the sea, and thus become 'interchangeable' with deck officers, as Fisher proposed [40].

Submariners posed far less of a threat to the officers of the surface fleet. They belonged to a closed service and had little contact with the big–ship navy for much of the year. The Submarine Branch was only 3,000 men strong in 1914, whereas there were already around 26,000 engineers in the Senior Service by 1900 [41]. Submariners were drawn, too, from the ranks of young executive officers, and though battleship sailors might laugh at the sight of a grimy submarine officer fresh from a tussle with an uncooperative petrol engine, he remained 'one of them'. No submariner could be accused of being an RAF officer in naval uniform, nor an uneducated civilian dressed as an engineer.

Existing prejudice was broken down as greater interaction between the Trade and the surface navy was actively encouraged in the last years of peace. To qualify for the higher ranks, officers needed watchkeeping and disciplinary experience which could not be gained in submarines. Advantage was therefore taken of the stipulation that lieutenants could not serve their eight years in boats consecutively to send them to the surface fleet as watch officers – a system initiated by Edgar Lees [42].

At first, postings were for three–year periods, but this threatened to disrupt the efficiency of the submarine service and arrangements were made to modify the requirement to two years and then to one–year stints [43].

[39] Ibid p.722

[40] Mackay op.cit. pp.266, 275

[41] Penn op.cit. p.126

[42] Lees report 2 August 1905, Adm 1/7795

[43] 'Service for promotion' 27 March 1907, digest cut 11a, Adm 12/1440; 'Officers of the submarine service' 9 June 1914, digest cut 11a, Adm 12/1525. See also Chalmers op.cit. p.7

Watchkeeping attachments gave young officers the chance to appreciate the perspectives of the big–ship navy while showing the quarter–deck that submariners often made above–average naval officers. It was thus an important step towards the full integration of submarines into the Royal Navy. "They proved wonderful ambassadors," wrote Keyes of his big–ship submariners. "[They] recruited ardent spirits like their own and so we built up a magnificent *corps d'elite*." [44]

Exercises and manoeuvres

In the absence of real combat experience, the Edwardian Royal Navy assessed its submarines by conducting manoeuvres and war games designed to suggest tactics and reveal potential. It enjoyed only limited success in anticipating developments in submarine warfare, however; most exercises were artificial, unreliable, and structured in such a way that they tended to confirm the reliability of existing strategy rather than encourage the assessment of developing technology.

Before the first British submarines became available for comprehensive trials, evaluation was restricted to war games played by officers attending the Greenwich War Course. The games were, of course, highly artificial. Under Jane's rules, submarines could not reload within half an hour of firing a torpedo, and when submerged the submarine captain sat with his back to the rest of the players watching proceedings with the aid of "a small fragment of looking–glass, not exceeding half–an–inch in diameter." Greenwich rules were almost equally disadvantageous to the underwater weapon [45], although officers at Greenwich were showing healthy respect for submarines as early as 1901 [see section 6.3].

The annual manoeuvres should have offered better insights into the capabilities of the submarine, but various factors complicated evaluation of the new weapon. In particular, considerations of safety were paramount in formulating rules for the attack of submarines; nothing was allowed that would in any way endanger either crew or boat. A necessary side–effect

[44] Keyes, NM I, 46. See also Hall to Fisher 30 January 1912, FP 555

[45] 'Strategical wargame at Greenwich, January–May 1901' NID No.642, November 1901 pp.9, 14, Adm 231/35; Jane's rules cited by Compton–Hall op.cit. p.29

was that manoeuvres frequently lost all semblance of reality. Submarines cruised accompanied by a parent vessel carrying a large red flag, were ordered to display at least two feet of periscope at all times, and had to surface whenever they came within 1,000 yards of any other vessel.

Critics of the submarine alleged that the rules favoured underwater craft by preventing escorts from harrying them; proponents countered by arguing that the red flags and parent ships which encumbered submarines enabled surface vessels to keep well clear. Hall charged that the mother ship "entirely does away with the surprise... without being of any practical use to the submarines" [46], and noted after the 1910 manoeuvres that "it is almost impossible to unravel from these reports when the submarines were sighted due to rising in accordance with the 1,000 yard rule, and when their hulls or periscopes were sighted at some distance, either before they dived or in the act of attacking." [47]

Even when a submarine did get into position to deliver an attack, the rules generally forbade the actual firing of torpedoes fitted with collision heads, for fear that unacceptable damage would be caused below the waterline of the target ship. AK Wilson proposed that torpedoes should be fired during the 1904 Spithead manoeuvres, but even Fisher doubted the wisdom of the idea, and the cost of converting two old destroyers to withstand the impact of collision heads proved prohibitive [48]. Eventually it was decided that a limited number of practice torpedoes *could* be fired, so long as conditions were perfect, but even they were set to run under their targets [49] and not until 1910 did submarines have another opportunity to discharge torpedoes in fleet exercises [50]. Despite representations from senior officers, the practice was again prohibited in 1912 and 1913 [51].

[46] Hall memo 25 February 1910, Adm 1/8119; 'Fleet exercises 1908', July 1908, Adm 116/1090

[47] Hall to Neville 18 April 1910, Adm 1/8119

[48] On Fisher's dispute with Wilson, see 'Manoeuvres with destroyers' 20 January 1905, digest cut 11a, Adm 12/1414; Esher to Brett 14 March 1904, in Maurice Brett, ed., *Journals and letters of Reginald, Viscount Esher* (4 vols, London 1934–8) II, 50

[49] Wilson to Admiralty 23 August 1904, Adm 1/7719; DNO minute 14 January 1905, ibid; Admiralty to CinC Channel Fleet 9 July 1905, and reply 2 August 1905, Adm 144/27 fols.70–1.

[50] Admiralty to Hall 24 May 1910, Adm 1/8119

[51] Admiralty scheme of manoeuvres, June 1913, May papers MAY 10, National Maritime Museum; 'Report of Admiral of the Fleet Sir William May' nd (1913), ibid; Callaghan paper 'Remarks on North Sea strategy' 28 August 1913, Adm 116/1214.

The day–to–day operations of the Submarine Service were just as stringently controlled. Torpedoes were routinely run on courses marked out for the purpose, but these exercises were not tests of the weapons' accuracy. There was no target, and a successful run merely proved that the torpedo worked [52]. Dummy attacks on cruisers or battleships were restricted to the annual manoeuvres, and the substitutes available as targets for the rest of the year were usually either too small (torpedo boats) or too slow (sea–going depot ships) to be acceptable substitutes. The speed and manoeuvrability of target vessels were further restricted by considerations of fuel economy and safety. 'Tango–ing' (as evasive zig–zagging was then known) was forbidden for fear of damaging an attacking submarine [53].

In pre–war exercises, as in the annual manouevres proper, torpedo firing was carefully controlled. Although the importance of adequate practice was understood, and although torpedoes with collision heads could safely be fired under controlled conditions, the cost and effort involved in locating a rogue Whitehead had a sobering effect. A lost torpedo meant a formal Court of Inquiry [54]. Submarines were therefore encouraged to close the range decisively, and the majority of practice torpedoes were fired from unrealistically advantageous positions for fear of losing or damaging an expensive piece of equipment. In consequence, the percentage of torpedo hits recorded was high and British submarines were never fitted with the maximum possible number of torpedo tubes that wartime experience proved to be necessary [see section 6.2].

In Bacon's 1903 trials, 15 out of 20 attacks on the tender HMS *Hazard* were reckoned successful [55]. Exercises conducted after the 1904 manoeuvres resulted in 8 torpedoes out of 11 hitting a towed target,

[52] Alan Cowpe, *Underwater weapons and the Royal Navy* (unpublished PhD thesis, University of London 1979–80) pp.165–6

[53] Rules and conditions cited in 'Submarine administration', Admiralty Technical History vol.21 (October 1921) p.18, Naval Library MOD

[54] Callaghan report 21 January 1913, Adm 1/8629; Talbot diary 27 September 1906, Imperial War Museum 81/42/3. In the inter–war period, similar restrictions on the nature and frequency of anti–aircraft practices made exercises unrealistic and misleading, and suggested that ships were less vulnerable to air attack than they actually were (Till op.cit. pp.69, 190). In his book on American development of the machine gun, David Armstrong points out that strict limitations on the availability of practice ammunition severely compromised evaluation of the automatic weapon. See *Bullets and bureaucrats: the United States Army and the machine gun, 1861–1916* (Westport, Connecticut 1982) p.152

[55] Bacon report 'Remarks on the practices with submarine boats' 16 January 1904, Adm 1/7719

leading the ICS to the highly optimistic conclusion that a 1:4 ratio of hits to torpedoes fired might be expected in wartime [56]. Extensive torpedo practice conducted by the submarine branch in the years 1907–08 resulted in the discharge of 418 torpedoes and 67.2% hits against a moving target. Pleasingly consistent results were returned by all classes of submarine; A–boats averaged 65.75% hits, B class submarines 69.5% and the C class 68%, and these figures must have confirmed Hall in his belief that men were more important than *materiel*. More than half (50.7%) of all attacks made resulted in hits [57].

The Russo–Japanese war and the relatively realistic British manoeuvres of 1913 showed how unreliable such figures were. Just three of the 19 torpedoes fired during the Japanese assault on Port Arthur found a mark, despite good weather and the advantage of near–complete surprise. Only three of 275 Whiteheads discharged in the trio of major torpedo attacks that preceded the Battle of Tsushima, and no more than four of the 87 expended in the subsequent night action, scored hits [58]. In 1913, three of 24 torpedoes fitted with collision heads fired by destroyers against a fleet of 'enemy' ships steaming in line ahead struck home [59]. Submarines did not use Whiteheads in 1913, but during the Great War HMS *Vernon* recorded that British boats discharged a total of 348 torpedoes at enemy warships; just 31 of these (8.9%) hit their targets [60]. (Naval intelligence calculated that German U–boats, whose prey were generally slower merchant vessels, recorded 40% hits in 1915, improving this to 50% two years later [61].)

Nor were the Royal Navy's torpedoes reliable. 27 per cent of the Whiteheads fired by British submarines during the war suffered some form of mechanical failure, and unbeknown to the submarine service the collision heads fitted during peacetime exercises were about 60lbs lighter than

[56] Bacon and Charlton report 6 June 1904, Adm 144/27 fols.56–8

[57] Figures calculated from data in Hall's '5th annual report on submarines' 5 March 1908, Adm 1/7988. Salvo firing in some exercises rather disguised the number of unsuccessful attacks made in which no torpedoes were fired.

[58] BNA 1906 pp.110–15; Cowpe op.cit. pp.167–72

[59] Churchill to Asquith 30 August 1913, Adm 116/3381

[60] HMS *Vernon* annual report 1917 pp.163–4, Adm 187/37; HMS *Vernon* annual report 1918 p.152, Adm 187/38

[61] Holger Herwig, *'Luxury fleet': the Imperial German Navy 1888–1918* (London 1980) p.164

guncotton warheads, with the result that in war the depth–setting was incorrectly calculated and British torpedoes tended to run deep throughout 1914. Several German warships thus escaped an otherwise correctly–aimed Whitehead. Because they set their dummy torpedoes to run under their target, assessing hits by looking for torpedo tracks, British submariners also failed to recognise "the difficulty of getting a torpedo discharged at a depth of about 30 feet to pick up the shallow depth necessary to strike a torpedo craft at the short range essential to ensure success against a small vessel manoeuvring at speed" – about 800 yards [62]. Officers who had regularly 'hit' destroyers and torpedo boats in exercises found the feat almost impossible to repeat in wartime.

Manoeuvre restrictions on underwater craft and torpedo firing permitted wildly–differing interpretations of submarine performance, and the ease with which evidence could be made to support opposing viewpoints tended to discredit manoeuvres and thus reinforce the *status quo.* As Geoffrey Till points out in his study of airpower and the Royal Navy, the sort of restrictions imposed on aircraft and submarines "worked to the inevitable benefit of weapons like the battleship, whose value was already established, rather than to the... unproved alternatives." [63]

The factor of seniority also came into play, for by naval custom it fell to the senior officer present – invariably the captain of the warship attacked – to decide whether a submarine's torpedo would have hit and whether his counter–attack had been successfully delivered. "I think it will be universally conceded," noted Rear–Admiral EE Bradford, "that the system... is open to abuse and requires amendment." [64] The Umpire–in–Chief of the 1912 manoeuvres, Admiral May, drew attention to the same problem in his report. "A senior officer," he wrote, "may well feel that he has been over–powered, but hesitates to put his own ship out

[62] Keyes to Sturdee 1 November 1914, KP 4/34, quoted in Halpern I, 42–49. The figure for torpedo failures was calculated by Nicholas Lambert of Worcester college, Oxford, and I am indebted to him for permission to quote from his analysis.

[63] Till op.cit. pp.69, 190. The parallel of the great capital ship controversy is instructive: the evidence of manouevres and the experience of the Russo–Japanese war led one group to argue for small, manoeuvrable battleships with low speed, heavy armour and a multitude of small–calibre guns, while a rival faction emphasised the value of high speed, light armour and the heaviest possible armarment. Such divergences of opinion make the submarine look uncontroversial.

[64] Bradford report 24 July 1912, Adm 1/8269

of action due to fear of his motives being misconstrued, as well as to reluctance in voluntarily giving up the chance of further experience in conditions resembling war.... There is a growing feeling in the service now that for a junior to approach his senior on the opposite side is a risk greater than the occasion warrants." [65] Two years later, a writer in the *Naval Review* observed that "the umpires' reports are composed in the big ships, with the feeling of solid security that is engendered in them, so that though each year sees a little more notice given to submarines, the reports have rather the same colouring one would have expected if... the captain of the *Titanic* had reported upon the safety of his ship before leaving upon her last voyage." [66]

Reports on the manoeuvres of 1912 and 1913 confirm that some officers did use their seniority to overrule subordinates in command of submarines, and thus helped to obscure the threat posed by the new weapon. Even Custance noted "a general tendency... to put these vessels out of action somewhat too readily by the Senior Officers of larger ships." It should be stressed, however, that their animus was not specifically directed at the captains of underwater craft, but applied equally to the relatively junior officers commanding torpedo boats, destroyers and even cruisers [67]. There is also good evidence that the senior officers who umpired the manoeuvres – May prominent among them – were willing to overturn the more outrageous decisions made by senior officers on the spot [68].

5.3: The foreign context – Russia and the United States

If the Royal Navy could not rely upon its own manoeuvres to provide an accurate assessment of submarine development – and there was general

[65] 'Naval manouevres of 1912 – remarks by Umpire–in–Chief' 5 August 1912, Adm 1/8273. For a more colourful account, see Fisher to Balfour 8 September 1913, Add.Mss. 49712 fol.126

[66] 'The influence of the submarine on naval policy, part III' in *Naval Review*, August 1914 p.49

[67] Custance paper 'Criticisms of the 1913 manoeuvres' nd (?September 1913), Adm 116/1169. See also Callaghan report 'Manoeuvres 1912: General remarks by the Commander–in–Chief' 5 August 1912, Adm 1/8269; Churchill to Asquith nd (30 August 1913), Adm 116/3381

[68] See the detailed breakdown of claims and counter–claims in Umpire–in–Chief's report of August 1913, MAY 10

agreement that it would be unwise to do so – it could at least hope to glean useful insights from a study of its rivals. From 1901 to 1905 and beyond, this effectively meant the French, for although both the Russians and the Americans had developed submarines, neither did so with sustained vigour. Unfortunately for the British, pre-war French submarine policy oscillated between extremes, while the Germans – who at least brought a calm appraisal of technological limitations and strategical needs to the subject – gave no sign of appreciating the peculiar potential of the weapon that they were to exploit during the Great War. But a comparison between British, French, German, American and Russian evaluations of the submarine casts favourable light on many aspects of British submarine policy, as well as helping to explain why it took so long for the submarine's true worth to be recognised by the Royal Navy.

As we have seen, Russia was quick to realise that submarines were well suited to the coastal role that was so important to the Tsarist navy. Like France, she developed an imaginative submarine policy and produced some interesting and innovative boats, but paid the penalty for maintaining an inefficient arms industry. In addition, Russian submarine policy lacked ambition in the pre-war period.

After the last Drzewiecki boats were delivered, the navy discontinued submarine construction until the turn of the century. A boat named *Pyotr Koschka* built to the plans of a naval lieutenant, Kolbasev, was launched in 1902, but was not a success. She was too small and there were problems with the external Drzewiecki torpedo drop-collars (fitted instead of internal tubes), designed to allow torpedoes to be angled and fired on a variety of bearings [69]. The *Pyotr Koschka* was followed in 1903 by *Delfin*, which at 175/200 tons was quite an advance on her predecessor, and the latter boat was sufficiently successful for the Navy Ministry to place an order for 10 more submarines to both Russian and foreign designs.

Submarine development was spurred on by the Russo-Japanese war of 1904-05. The greater part of both Russia's Pacific and the Baltic fleets were wiped out, and after the Battle of Tsushima the Tsarist navy slipped overnight from third to sixth place in the naval rankings, falling behind the United States, Germany and Japan. 18 first- and second-class battleships

[69] For an assessment of the Drzewiecki drop-collar (which was widely fitted in French and Russian submarines), see Bacon report 'Drzewiecki torpedo discharge gear for submarine boats' 2 July 1901, Adm 1/7522

were lost, and the submarine service was probably the only branch of the navy to grow during the conflict [70].

Several old Drzewiecki submarines were brought back into service, and the Russian navy went to extraordinary lengths to smuggle its new Lake craft past American customs boats on the lookout for contrabrand of war [71]. A public subscription of £1.4m was raised and used to order 18 destroyers and three submarines from Russian yards [72]; at least eight boats were dismantled and sent by rail to the Pacific theatre [73]. Russian boats were used to patrol the approaches to Vladivostock, operating up to 120 miles from the port. They encountered Japanese warships on only one occasion; in the spring of 1905 three submarines, including *Delfin*, were on a patrol line 70 miles from Vladivostock when they sighted two Japanese destroyers. The Holland boat *Som*, which was closest to the TBDs, attempted to manoeuvre into position for a surface attack, but the Japanese ships withdrew [74]. Old photographs also show that at least one Drzewiecki boat was present at the siege of Port Arthur.

Of course, nations at war often buy up weaponry almost indiscriminately, and the significance of Russia's dealings with Lake, Holland and Krupp, the leading German submarine builder, should not be over-estimated. Nevertheless, it was not something that would have been done even five years earlier. The Russo-Japanese war was an important proving ground for underwater warfare, and the submarine emerged from it as a viable weapon.

Both the mine and the locomotive torpedo won dramatic victories in the Far East. Four battleships – two on each side – were lost to enemy mines, and the death of Admiral Stefan Makarov in a Japanese minefield was a turning point in the war at sea. The British Admiralty took note of

[70] DW Mitchell, *A history of Russian and Soviet sea-power* (London 1974) pp.267-71

[71] PA Towle, *The influence of the Russo-Japanese war on British military and naval thought* (unpublished University of London PhD thesis 1973) p.376; Simon Lake, *Submarine* (New York 1938) pp.171-84

[72] 'Foreign naval progress and estimates 1905' (Russia), NID No.776, July 1905 p.40, Adm 231/44.

[73] Jacob Kipp, 'Undersea warfare in Russian and Soviet naval art: historical background 1853-1941', paper delivered at the Undersea Warfare Conference, Dalhousie University, Halifax, 21-24 June 1989 pp.12-13; Michael Wilson, *Baltic assignment: British submariners in Russia 1914-1919*, London 1985 p.44; Mitchell op.cit. p.275

[74] Kipp op.cit. p.13

the "startling success" of "these deadly contrivances", and observed that "the results accomplished have been enough to rout any lingering traces of scepticism". A thorough revision of mining policy was recommended [75], and significant attempts were made to improve the underwater protection of British warships [76]. Even the notably conservative Admiral Beresford was driven to observe that "the war in the Far East has ...[shown]... the danger of under water warfare, a danger we have been in the habit of under-rating in this country." [77]

Torpedoes exercised a similar influence on the war, though a significant group of naval thinkers, led by Admiral Custance, concluded an analysis which suggested that the Whitehead threat had been much exaggerated [78]. In general the torpedoes used by both sides lacked the speed and range to be effective, and as we have seen, few actual hits were scored. The results secured by those few strikes were, however, impressive; at Tsushima five of the Russian ships sunk suffered torpedo hits, and the four Whiteheads that hit the battleships *Suvoroff* and *Navarin* (two each) were directly responsible for the respective losses of those ships.

Few observers seem to have commented on the far more striking moral effect created by torpedo warfare. Every attack caused the enemy to scatter or turn away in confusion, and far from being a decisive weapon used to deliver the *coup de grace*, as its proponents had expected, the Whitehead emerged from the war as a demoralising weapon of confusion best used before a gun battle, or afterwards in mopping-up operations [79].

The submarine also helped towards the creation of a climate of fear. Knowing that the Japanese had acquired some Holland boats, the Russians of Rodzhestvensky's Baltic squadrons wove them into their collective fantasies, reporting sightings of submarines in the Baltic and off Sumatra. Rumours that Japanese boats had taken part in the Battle of Tsushima

[75] 'Submarine automatic mines – memorandum by Admiralty' 13 March 1905, Cab 38/8/22

[76] Towle op.cit. p.197

[77] Beresford to Balfour 7 March 1908, Balfour papers Add.Mss. 49713

[78] Reginald Custance, 'The Whitehead torpedo in war: its use against single ships by surface craft and submarines' (privately printed paper read to the War College 11 June 1914), KP 4/8

[79] Cowpe op.cit. pp.167-72

reached the British Embassy in Peking. For its part, the IJN suspected Russian submarines were responsible for the loss of the battleship *Yashima*, which went down in a minefield in May 1904 [80]. Russian and Japanese fear of the elusive submarine presaged the cautious dread that swept the North Sea clear of major surface units during the Great War.

The unsuccessful prosecution of the Russo–Japanese war led, not unnaturally, to a revision of Tsarist naval policy. The big–ship school, which had been in the ascendant since the mid–1890s, was temporarily discredited. An ambitious rebuilding programme put forward in 1907 to restore Russian supremacy over the German Baltic fleet and rectify the damaging shortage of naval auxiliaries felt in the Far Eastern war collapsed in the face of left–wing opposition from the Third Duma of 1907–12. The Russian parliament insisted on linking naval reconstruction with administrative reform, and in addition feared a recurrence of the mutinous fervour which swept the navy in 1905. It was not until the appointment of Admiral I.K. Grigorovich as naval minister in 1911 that the Tsarist navy began to regain its feet [81].

In these conditions the submarine, which was cheap and had not been discredited by the war, enjoyed something of a vogue. The first post–war Russian programme called for the creation of two 'divisions of submarines' – one made up of new boats and the other of obsolescent types, which would serve as a reserve. Seven submarines – including *Krab*, the world's first submarine minelayer – were ordered for the Black Sea fleet, and a further seven for the Baltic fleet, as part of the 1907–08 programme. Russian designs nevertheless remained experimental, and the Duma's financial stringency meant that all the boats were delayed and a number of vessels had to be funded by public subscription. In 1912 funding was authorised for 12 new Baltic submarines and six boats for the Pacific, and by 1914 there were 48 submarines in service, half of them obsolete, built to at least 10 different designs. The most recently completed boat available to the Russians was the twin–diesel engined *Akula*, a successful and heavily–armed boat which had nevertheless been laid down as early as 1906.

[80] Mitchell op.cit. pp.222, 237, 245; 'Battle of Ushimer Strait' 1 August 1905, digest cut 11a, Adm 12/1414

[81] NE Saul, *Sailors in revolt: the Russian Baltic fleet in 1917* (Lawrence, Kansas 1978), pp.4–8

The Russians continued to build submarines to augment their coastal defences and operate in support of the army, as they had done in the nineteenth century. The shallow waters of the Baltic were particularly suited to the operations of underwater craft, while the Pacific fleet needed submarine boats to offset the local superiority of the Imperial Japanese Navy; in 1909 there were five submarines in the Baltic, five in the Black Sea but 14 (admittedly elderly) boats in the Pacific [82]. In the west, successive war-games played in the period 1900-1903 suggested that a landing and naval assault could lead to the fall of St Petersburg [83], and in consequence Russian Baltic submarines were generally confined to operations in front of the minefields laid in the Gulf of Finland and the Bay of Riga during the Great War. With some British E-class submarines to support them, Russian boats did venture further afield, but they were generally unsuccessful.

Few up-to-date craft were available; the poorly-trained personnel were increasingly unwilling to venture into a sea which fast became one enormous minefield. When German ships were sighted, Russian submarines tended to launch attacks from long range, and despite years of expertise in underwater warfare, Russian torpedoes often failed. In 1914 and 1915, 23 torpedo attacks were delivered by boats of the Baltic flotillas, but no hits were secured. Black Sea submarines had more success, patrolling the Bosphorus, laying hundreds of mines and sinking a number of Ottoman auxiliaries, but they could not cut the Turks' Anatolian supply lines to support the army's Caucasus campaign [84].

Russian naval planning became considerably more ambitious in the early stages of the war. 30 additional submarines were projected late in 1914, and the Chief of the Naval General Staff called for 114 boats to be built by 1917-18. Some of these craft would have been monstrous 2,000-ton cruiser submarines, and in 1912 a plan for a 4,500 ton boat to be armed with 60 torpedoes and 120 mines was allegedly considered. Such grandiose projects were however well beyond the capabilities of the contemporary Russian arms industry, and during the war the Tsarist navy had to be

[82] Anon, 'The present condition of submarine boats', RUSI Jo. LIII pt.1 (1909) pp.1293-4; details of the 1908 and 1912 programmes from Kipp op.cit. pp.16-18

[83] Mitchell op.cit. p.288

[84] See eg Wilson op.cit. pp.66, 180-1; Kipp op.cit. pp.20, 23-4

supported by a British submarine flotilla and a consignment of a dozen 350−ton Electric Boat Co. craft from the United States [85].

American submarine development was in its way as disappointing as that of Russia. At the turn of the century, the United States possessed submarine boats every bit as good as, and considerably more promising than, those of the French. But the US Navy was not enthusiastic about the new weapon. As we have seen, the private Holland company was largely responsible for creating what submarine designs there were, and the unrealistic specifications of the navy department had led to the construction of the unworkable *Plunger*.

Having acquired a far better boat in the *Holland VI*, the USN singularly failed to take advantage of its good fortune; as the British naval attache noted late in December 1900, "even now the navy are very lukewarm as regards these boats. Few that I have met put any faith in them, except as being small beginnings from which great things may come." [86] There were several reasons for this failure. For one thing, American home waters were considerably less vulnerable than those of Russia; for another, the perfection of the submarine coincided with a significant attempt to expand the US surface fleet with the eventual aim of making it 'a navy second to none'. The USN emerged from the Spanish−American war with considerable credit, and the conflict − fought far from America's own shores − did much to popularise a Mahanite conception of sea−power. There was an empire newly−won to be defended from avaricious rivals such as Germany and Japan, and the navy, encouraged by President Roosevelt, entered a period of rapid expansion in which emphasis was placed on building up its battleship strength. The fleet that emerged was noticeably top−heavy, deficient not only in submarines but in cruisers and destroyers as well [87].

The state of the turn−of−the−century US arms industry also slowed the pace of American submarine development. Construction was left in the hands of two small firms, the Holland and Lake companies − the former

[85] Mitchell op.cit. p.290

[86] Quoted in 'Extracts from naval attaches' reports', HMS *Vernon* annual report 1901, Adm 189/21 p.153

[87] Cf. RW Turk, 'Defending the new empire, 1900−1914' in KJ Hagan, ed, *In peace and war: interpretations of American naval history, 1775−1984* (Westport, Connecticut 1984) pp.186−205

having a virtual monopoly. Neither received significant support from the USN, and the evolution of the American submarine therefore depended upon the limited research and development conducted by private concerns. The USN treated its suppliers warily, and failed to co-operate with them as fully as did the British Admiralty with its contractors. Although the United States developed its submarines from the same Holland type chosen by the United Kingdom, therefore, it did so both less ambitiously and rather less successfully. The average American submarine was smaller, had an inferior radius of action, and was less heavily armed than its British contemporary.

Thus, while both the American and British submarine programmes were similarly coherent, the USN lagged behind from the start. The British *Hollands* were (as we saw in section 2) put in hand after the United States laid down its own, nearly-identical *Adder* class, but they were in service some months before the American boats. The *Adder*'s periscope was distinctly inferior to the British type, and as late as 1905 ventilator problems meant that she was taking a quite unacceptable 28 minutes to dive [88]. The United States had eight submarines built or building in 1900, but only ten more were added in the next seven years and in 1910 only 18 boats were in service; by then the British had 60 [89]. The USN did introduce twin-shaft propulsion, but was well behind the Royal Navy when it came to developing the diesel engine. The RN fitted an experimental model to *A13* in 1905, while the Americans persevered with the petrol motor until the *Skipjack* was commissioned in 1911: a significant failing. Nor did the United States follow Britain's lead away from the basic Holland type by fitting 'saddle tanks' for water ballast and using the extra space created inside the pressure hull to enhance habitability and create boats capable of operating overseas. By 1914 the USN had produced the H class submarine – a boat as good, in her way, as the British E, and one that was successful in British service. But she was 300 tons smaller, less seaworthy and had diesels which, though they were capable of similar speeds, developed barely half the horsepower of the British engines.

American submarine development was further retarded by a variety of

[88] 'United States: fleet, dockyards &c.' in 'Reports on naval affairs 1904' vol.II, NID No.745, January 1905, Adm 231/42

[89] William Jameson, *The most formidable thing: the story of the submarine from its earliest days to the end of World War I* (London 1965) pp.94, 103

factors. To begin with, the USN was never able to decide between the rival Lake and Holland designs. Simon Lake had competed against Holland in the 1893 USN competition, and by 1902 the Connecticut Yankee had completed three prototype boats. But Lake's submarines were not conceived on the same lines as Holland's; the inventor believed underwater craft had commercial potential and envisaged their use for cable maintenance, oyster fishing and salvage. Lake boats were fitted with diving chambers, cable-cutting apparatus and wheels for running along the seabed - modifications that failed to impress the British Admiralty, which commented: "All this class of appliance is absolutely out of place in a sea-going submarine... it is precisely as reasonable to suggest fitting destroyers with buckets so that they can be used in their spare moments as dredgers." [90]

A succession of competitive trials (1907) indicated that both the Lake and Holland types had considerable merits, but it was generally felt that the Electric Boat Co.'s *Octopus* was superior to the *Simon Lake X* [91]. However the government refused to allow the EBC a monopoly, and ordered three Lake submarines of the G class between 1910 and 1912, and three more as part of the L class in 1914 [92].

Further problems were caused by the suggestion that flotillas of underwater craft might provide a cheap alternative to a surface fleet. The revival of the USN as an ocean-going force dated only to the mid-1880s, and civilian navalists and many serving officers feared that America might revert to her old, cheap policy of maintaining a navy suitable only for coast defence. As Isaac Rice informed Vickers, the USN was therefore "opposed to submarine boats for the reason - as ex-President Roosevelt told me several years ago - that they fear that if they advocate submarines, Congress will no longer vote for battleships." [93]

One final bone of contention was the damaging division of responsibility for the naval aspects of coastal defence. The Army artillery corps, which

[90] Admiralty note marked 'Letter enclosed by Sir Andrew Noble', nd (1905), d'Eyncourt papers DEY 6, National Maritime Museum

[91] 'Foreign naval progress and estimates 1906-07' (USA), NID No.834, September 1907 pp.120-4, Adm 231/48

[92] Bayly to Sturdee 6 December 1901, Adm 1/7529; Rice to Vickers 24 February 1903, Vickers Papers VP 632/161 fols.17-19, Cambridge University Library; Rice to Vickers 8 November 1909, ibid fol.124

[93] Rice to Albert Vickers 30 December 1910, ibid fol.133. See also Frank Cable, *The birth and development of the American submarine* (New York 1924) p.171

– like the Royal Engineers – was charged with the maintenance of mine defences, took an early interest in submarines, and the ensuing coast defence debate aroused a great deal of acrimony between the two services. Matters were not helped by the army's declared preference for the Lake type ("a most valuable auxiliary to the fixed mine defences... it will give the nearest approach to absolute protection now known" [94]), which was designed to allow divers in and out of the boat for the inspection or destruction of minefields [95].

The submarine was, nevertheless, a useful addition to the American naval arsenal. In the early years of the twentieth century, US attention was fixed firmly on the Caribbean, where territories seized during the Spanish–American war seemed threatened by an expansionist Germany. The Venezualan disputes and the construction of a Panamanian canal in their different ways suggested that the USN could and should concentrate its battleships in the Atlantic, and in 1905 all capital ships were withdrawn from the Pacific theatre [96]. This strategy left the Philippines and the Hawaiian Islands exposed to the growing threat of Japan, and the American 'Orange plan' of 1907 assumed that in the event of war between the two powers, the IJN would have a free hand in the Pacific for several months. During this time the Japanese were expected to attack both Manila and Honolulu, as well as Samoa, Guam and the Panama canal [97]. To compensate for this weakness, about half of America's submarine force was sent to the Pacific between 1909 and 1914. Six *Adders* went to the Phillipines in 1909, to be joined in 1912 by the three boats of the *Viper* class. Several *Carps* were despatched to Honolulu, while *Octopus*–type submarines were used to patrol the approaches to the Panamanian canal.

Before 1914, therefore, American submarine policy was definitely defensive. The USN boats in service at that date were all short–range

[94] Quoted in 'Foreign naval progress and estimates 1904' (USA), NID No.738, July 1904 p.90, Adm 231/41. For an analysis of US coast defence policy, particularly in the nineteenth century, see Robert Browning III, *Two if by sea: the development of American coastal defense policy* (Westport, Connecticut 1983), esp. pp.161–7

[95] 'Foreign naval progress and estimates 1904' (USA), NID No.738, July 1904 p.90, Adm 231/41; 'United States: fleet, dockyards &c' in 'Reports on naval affairs 1904' vol.II, NID No.745, January 1905, Adm 231/42. See also Army board report 'Submarine boats in their military aspect of submarine defence' nd (1904), Naval Library pamphlet P.475

[96] Turk op.cit. p.187

[97] Ibid p.196

coastal craft, and a fair proportion were obsolesecent. The huge distances that separated the United States from any potential enemy discouraged consideration of more ambitious projects, for many years. 'Fleet' submarines were not developed until 1915. American policy, though sensible, thus contained few lessons for the RN since it developed broadly parallel to, but slightly behind, British submarine strategy.

The foreign context – France

The French navy, on the other hand, continued to develop submarines with some enthusiasm. None of the great naval powers could match France's commitment to underwater warfare, which was maintained at the expense of her battleship and cruiser programmes; for three consecutive years (1906–08) the proportion of the French construction estimates devoted to submarines topped 20%, and in the period 1901–1914 it averaged 15.3%. In Great Britain, submarine building never represented more than 9.5% of total construction, while in Germany the maximum was 13.4%, in 1914. British and German averages (for the years 1901–1914 and 1905–1914 respectively) were 4.9% and 7.9% of the construction estimates [see appendix 3].

Unfortunately for the French, the *Marine Francaise* never developed submarines as consistently as did the British and German navies. Rival designers made furious attacks on each other; successive Ministers of Marine spent much of their time undoing the work of their predecessors. There were long and bitter disputes between the proponents of true submarines – boats powered solely by electric motors which were intended to patrol submerged in the approaches to a port during the day, returning to recharge their batteries at a shore station by night – and those who contended that longer–range 'submersibles' [98], with improved buoyancy and diesel or steam engines for running on the surface (which meant that batteries could be recharged at sea), were the only sensible way forward. The debate began with the commissioning of the *Narval* in 1900, and was

[98] Since the French made a distinction between 'submarine' and 'submersible', I have adopted their usage in this section. Elsewhere in the thesis, the term 'submarine' is applied, in the British sense, to all submergible boats.

not settled in favour of the submersible until about 1909 [99].

The *Narval* was the world's first double-hulled submersible. Her design called for the pressure hull, which had to be circular to present the best possible resistance to water pressure, to be sheathed in an outer shell. This second hull housed large ballast tanks which gave increased buoyancy on the surface (but slowed diving time), and was designed to improve sea-keeping. The inventor, a naval architect named Maxime Laubeuf, also provided the boat with a reasonably efficient dual-propulsion system. His plans won an open competition similar to those organised in the United States, defeating 28 other entries.

The *Narval* was not, in fact, a large boat, being of only 117/202 tonnes displacement; at 111ft she was 48ft shorter than the old *Gustave Zede*. She was, however, an advance on her contemporary, the submarine *Morse*, whose displacement of 143/149 tonnes left a tiny safety margin of six tonnes positive buoyancy (4%). (By way of comparison, the British A class had a 9% margin, while French submersibles of the *Brumaire* class boasted 28% positive buoyancy.) *Morse*, which had originally been designed for petrol/electric propulsion, was completed with only a single-shaft electric motor. The French followed these two boats, *Morse* and *Narval*, with numerous classes of submarines and submersibles. The *Morse* was succeeded by six similar submarines (two of them paid for by a public subscription raised by *Le Matin*) and twenty tiny (71/74 tonne) harbour-defence vessels of the *Naiade* class. Meanwhile six improved *Narvals* were ordered in 1900, only four of which were eventually delivered.

Plainly an assessment of the relative virtues of submarine and submersible was called for, and between 1901 and 1903 three experimental craft (named *X*, *Y* and *Z*) were laid down. They were provided with a variety of engines for surface propulsion: *Z* had a diesel engine, *X* a twin-shaft benzol motor and *Y* an experimental closed-cycle diesel. When the most successful (and most orthodox) of these boats, the submarine *Z*, was completed, she was matched against the latest submersible, *Aigrette* – the world's first diesel-engined boat – in a series of competitive trials held at Cherbourg in March 1904.

[99] On the general development of French naval policy in this period, see John Walser, *France's search for a battlefleet: French naval policy 1898–1914* (unpublished PhD thesis, University of North Carolina (Chapel Hill) 1976). Walser discusses the uncertainty of French strategic policy on several occasions – cf. pp.49–50, 107–11, 199–200, 406.

The trials were authorised by the Minister of Marine, Camille Pelletan. Pelletan favoured submarine development, and according to one authority, "at no point during his ministerial career did he question the assumption that the submarine and the torpedo boat were superior to the armour and artillery of the battleship." [100] He accepted that future designs would have to be larger to ensure better seakeeping, but stressed the virtues of minimal surface buoyancy: "The chief guarantee that a submarine posseses against destruction is that of being able to disappear quickly," proclaimed the Minister, "and it is this quality that gives superiority to the submarine proper over the submersible type." [101] Pelletan felt strongly enough on the subject to cancel an order for 11 improved *Aigrettes* in 1902, allegedly to show his dislike for Laubeuf, the designer. Paradoxically, however, the trials which he had ordered conclusively proved the versatility of the submersible.

Surface and submerged speed, diving time and habitability were compared. To the surprise of all concerned, the *Aigrette* proved herself superior in each instance, winning even the tests of diving time and performance submerged in which *Z* had been expected to have the edge. In fact the submarine managed only 4.1 knots underwater – her design had called for 7.1 knots – and took a full ten minutes to dive when ordered to do so unexpectedly; before the trials began her advertised diving time had been around 90 seconds. The *Aigrette* was only a third of a knot outside her designed submerged speed of 6.7 knots, and dived in five and a half minutes – impressive for the day, if still a dangerously slow time by the standards of the First World War [102].

Pelletan was dismissed in January 1905, and his successor, Gaston Thomson, proved to be a proponent of the submersible. Thomson cancelled as many as possible of the tiny 44–ton *Guepe* type submarines favoured by his predecessor and made plans to substitute a smaller number of submersibles. However the change in policy caused a hiatus in French construction, which had already suffered from Pelletan's attempts to introduce sweeping changes; no boats were commissioned in the year

[100] Ibid p.199

[101] Speech by Pelletan (December 1903) reported in 'Foreign naval progress and estimates 1904' (France) NID No.738, July 1904 pp.39–40, Adm 231/41

[102] 'Foreign naval progress and estimates 1905' (France) NID No.776, July 1905 pp.18–19, Adm 231/44

1906–07, and the completion dates of those ordered under the 1906 programme were put back to 1909 or 1910 [103].

The inefficient and strike–ridden French dockyards took years longer than their foreign rivals to build submarines in the pre–war period. The submersible *Amiral Bourgois* was ordered under the 1906 programme and not completed until 1914, and in 1908 *Brassey's naval annual* noted that "it appears that of 53 submarines and submersibles laid down from 1903 to 1907 not one has been completed for service, although four are under trial and six others have been launched, the rest being in hand or existing only on paper." [104] Dockyard inefficiency was compounded by the navy's tendency to delay construction while conducting trials with its numerous experimental vessels – with results that can only have reinforced SS Hall's commitment to a policy of homogeneity and infrequent improvements in *materiel*. In addition, the large numbers of boats under construction at any one time meant that the estimates were sometimes eked out in a ridiculous way. For example, £12,216 was spent on the submarine *Naiade* in 1902 of an estimated total cost of £14,600. In 1903 expenditure was £1,857, and the boat was still in shipyard hands in 1904, £712 being appropriated for work on her in the estimates for that year. In 1906, £68,752 was earmarked for the construction of the submarines *Emeraude*, *Opale* and *Rubis*; next year work on the three boats, together, cost the French Navy £670 [105].

By early 1914, the French had submarines and submersibles of nineteen different classes or sub–classes built and building. 28 separate types had been constructed or projected since 1885. Only three classes of submarine were built in any numbers – there were 20 tiny *Naiades* (all of them stricken just before the war) and 34 boats of the *Brumaire* and *Pluvoise* classes. These latter types were nearly identical, 18 steam–powered *Pluvoises* being built to a Laubeuf design between 1905 and 1911 while 16 diesel–engined *Brumaires*, with the same hull but slightly greater speed, were ordered in 1905–06 and completed between 1912 and 1914.

The backwardness of French naval technology was exacerbated by both

[103] 'Foreign naval progress and estimates 1906–07' (France) NID No.834, September 1907 pp.9–11, Adm 231/48; Murray Sueter, *Evolution of the submarine boat, mine and torpedo*, Portsmouth 1907, pp.105–06

[104] BNA 1908 p.20; see also Walser op.cit. pp.22, 134

[105] See BNA 1902, 1903, 1904, 1906, 1907 for breakdowns of French naval estimates.

shortage of funds and the strategic uncertainty that pervaded the *Marine Francaise* before the war. The navy had to make do with construction estimates of £3–4 million per annum while the British and German estimates spiralled upwards to top £13 million and £9 million respectively, and French preoccupation with the Prussian military threat not unnaturally dominated the issue of national defence, causing funds to be diverted to the army. To make matters worse, Pelletan persisted in treating the navy as an administrative and budgetary unit rather than as a combat arm, curtailing manoeuvres and exercises, and discouraging staff work and planning as the tools of warlike nations. Naval bases were run down, and individual ships were kept on the active list into extreme old age [106].

Although Gaston Thomson and his successors largely reversed Pelletan's policies, their effect on the efficiency of the French Navy had not been entirely overcome by 1914. Traditionally second among the world's naval powers, France had dropped to an inglorious fourth place by 1914 – behind Britain, Germany and the United States, and roughly level with Japan. Her naval strategy was undermined by unexpected political and military developments, beginning with the *entente cordiale*. The great French ports never came under attack, the country's numerous harbour defence boats were not required to go into action during the Great War, and the British and Italians necessarily shouldered much of the burden of blockading the German and Austrian fleets, robbing French submersibles of a possible role in the war at sea.

In the pre–war period most French submarines and submersibles were in any case designed for coast defence. The *Marine Francaise* was probably the first navy to recognise the implications underwater craft had for the blockade and for the naval defence of colonies. The success of submarine flotillas in the 1902 manoeuvres, wrote one French submariner, was "sufficiently considerable to enable it to be confidently affirmed that, with the present boats, imperfect as they may be, an enemy will suffer severe loss in attempting to enter or leave a port the approaches to which are guarded by hostile submarines." [107] Submarines and submersibles were soon distributed around the coasts and overseas as part of the country's

[106] Walser op.cit. pp.217–18

[107] Precis of report by Commander Heilmann of the French submarine service in 'French manoeuvres 1902' NID No.692, June 1903 p.65, Adm 231/37

defences mobiles. From 1903 flotillas were stationed along the French Mediterranean littoral and at Bizerta on the Tunisean coast, promising domination of appreciable areas of sea [108]. "With torpedo boats and submarines," Pelletan maintained, "what do we have to fear for our colonies?" [109]

Most French submarine boats were, however, kept in home waters to guard a chain of *ports de refuge* intended to give battle squadrons protection from torpedo craft or superior enemy forces. "It may be said that the sole reason for fortifying many of the French ports was that by so doing the places fortified would be made into retreats in which French fighting vessels would be safe from their pursuers," a British report observed [110].

French boats frequently proved their worth in harbour defence roles. In the 1906 Mediterranean manoeuvres, submarines guarding Marseilles torpedoed 14 of the 23 warships attacking the port, scoring at least 18 hits. Three days later, a second operation saw the same boats protecting a defeated squadron bottled up in Marseilles by a larger fleet. Very similar results were obtained on this occasion, 14 of the 22 attacking ships being hit by a total of 23 torpedoes. Conditions were favourable for torpedo attack, and the surface fleet was not permitted to counter as vigorously as it might have done, but the manoeuvres did demonstrate the dangers of closely blockading a port defended by torpedo flotillas [111]. After the exercises had been terminated, Vice-Admiral Fournier, the Commander-in-Chief of the *defences mobiles* (who had been, it should be noted, a fervent proponent of underwater craft since about 1898), announced that submarines had torpedoed his flagship eight times in the manoeuvre period and had prevented him from carrying out several of his intended plans [112].

Britain and France differed fundamentally on the question of port

[108] 'France: fleet, dockyards &c.' in 'Reports on foreign naval affairs 1904', NID No.712, August 1904 p.68, Adm 231/39

[109] Quoted in Walser, op.cit. p.221

[110] 'France: coast defences' vol.II, NID No.729, August 1904 p.5, Adm 231/41

[111] 'Foreign naval progress and estimates 1906-07' (France) NID No.834, September 1907 pp.28-9, Adm 231/48

[112] Sueter op.cit. pp.109-110; Herbert Fyfe, *Submarine warfare* (2nd edition, London 1907) p.18. On Fournier's personal beliefs, see Walser op.cit. pp.19, 64, 69, 165-7, 242

defence policy. British submarines were (as we shall see) intended to safeguard harbours and the coasts in the absence of the surface fleet; French boats were there to protect ships. From this point of view, Gallic interest in small, manouevrable short–range vessels made sense. British submarines had to secure long stretches of coastline against possible invasion or raids. They would operate, moreover, in the heavy seas around the British Isles. French boats protecting a newly–arrived battle–squadron could predict with more certainty just where and when an attack would be delivered. Knowing this, and having only the approaches of a *port de refuge* to patrol, continually–submerged, electrically–powered submarines designed for optimum underwater performance might have the edge over a larger submersible which would have to crash dive when an enemy hove into view and then operate in shallow and confined waters. The weakness of France's construction policy was that many of her all–electric submarines never really embodied the theoretical virtues of the type. When naval planners began to envisage more ambitious roles for their submarine flotillas, important shortcomings were laid bare.

It did not take much imagination to envisage the submarine boats that so effectively protected their own ports creating havoc in the harbours of an enemy. The idea of infiltrating defended ports had been mooted in the 1890s, but there is little evidence that it was popular among policy–makers until about 1905–06, when the navy reverted to the construction of 400–ton submersibles [113]. Even then, the more seaworthy submersibles produced in large and homogenous classes by the Thomson administration were still designated 'defensive' weapons; their longer range was intended to permit the defence of the whole coastline rather than the immediate approaches to a port. From 1906 flotillas were based at Toulon, Rochefort, Cherbourg, Dunkirk, Bizerta and Saigon [114], and a number of large coastal or 'anti–blockade' submersibles of the *Gorgone* and *Clorinde* classes were ordered as late as 1909–12 – years that saw Britain and Germany step up production of 'overseas' submarines.

The French did, however, develop a number of plans for deploying boats off an enemy's coast. In the 1909 manoeuvres, two *Pluvoise* class steam submersibles and the submarine *Emeraude* were sent 400 miles to

[113] Cf. Lees report 'Proposed experimental submarine boat' 16 November 1905, Adm 138/360A section 12

[114] Arthur Hezlet, *The submarine and sea–power*, London 1967 p.18

blockade Cherbourg. They remained on a diving patrol off the port for three days, and the exercise indicated that the submersibles, at least, could have remained on station longer if necessary. Several *Pluvoises* performed impressive feats of navigation in the same period; one, the *Papin*, made an unescorted 1230 mile journey from Cherbourg to Oran – across a stormy Bay of Biscay – and covered 2,300 miles in three weeks [115].

Work on purpose-built *sous-marins de haut mere* was, nevertheless, still in its infancy when war broke out. Four experimental craft of varied design – *Amiral Bourgois*, *Charles Brun*, *Archimede* and *Mariotte* – were ordered between 1906 and 1908, but of these only the *Archimede* (completed 1911) and the less-than-satisfactory *Mariotte* (1913) were serviceable in August 1914. The equally experimental *Gustave Zede* joined them shortly after the outbreak of war; she was one of two winners of a competition to produce a 'high seas' submersible organised in 1909 [116].

French submarines and submersibles gave valuable but unspectacular service in the Great War; the majority served out the hostilities as port defence craft or on patrol in the Mediterranean. It is difficult, and perhaps unfair, to compare the performances of Entente submarines, but the *Marine Francaise* was disappointed by the performance of its boats. An unsuccessful attempt to send the submarine *Mariotte* (popularly known as 'the toothbrush' in reference to her unusual hull-form) into the Sea of Marmara in July 1915 caused the depressed Admiral Guepratte to confide to Keyes that though French "had taken such pride in their submarine service before the war, and thought they were the best, we went everywhere as we liked, our crews were splendid – they with the best intentions were always failing." [117]

The foreign context – Germany

For a nation later so intimately associated with the submarine, Germany paid little attention to underwater warfare before 1914. The first U-boat

[115] Jameson op.cit. pp.93–4

[116] Henri Le Masson, *Les sous-marins Francais, des origenes (1800) a nos jours (Brest 1980)* pp.114–16

[117] Keyes to his wife 30 July 1915, KP 2/13, in Halpern I p.172. See also Jameson op.cit. p.144; Compton-Hall op.cit. pp.90–1; Kenneth Edwards, *We dive at dawn* (London 1939) pp.90–2

was not commissioned until 1906, and in 1914 the Imperial German Navy had only 29 boats to set against the RN total of 72. However, most of these submarines were of large, seaworthy types and proved perfectly suited to commerce raiding.

Individual Germans did show considerable interest in underwater craft. At the inaugural meeting of the Technical Shipbuilding Society (1899), the chairman, Professor Busley, gave a speech on submarine development to date at the specific request of the Kaiser. The navy's Torpedo Inspectorate, charged with monitoring foreign submarine development, also favoured construction [118], and a low-key research programme was instituted at the Imperial dockyard at Danzig [119].

But proponents of the submarine faced intractable opposition from Alfred von Tirpitz, the State Secretary for the Navy, who was responsible for a revolution in Imperial naval policy. In the 1890s, Germany's economic and military domination of continental Europe was not reflected in its overseas trade and colonial possessions; and given the Mahanite climate of the age, a reassessment of Imperial policy was widely favoured. Tirpitz's solution to the problem of German naval inferiority – the famous 'Risk theory' – was startling in its originality and staggering in its implications. The idea that Wilhelmine Germany should fight a Franco-Russian alliance with cruiser squadrons (favoured by Tirpitz's predecessor, Hollmann) was abandoned. The new State Secretary was determined to build a fleet that could challenge British naval superiority. He persuaded the Reichstag to adopt an ambitious and irreversible programme of capital ship construction, cancelled programmes he felt were diverting funds from battleship construction, and propounded the big-ship doctrine of the 'decisive battle' [120].

Tirpitz's plan required considerable political nerve from its creator. The Reichstag would reject any indisciplined scheme for a 'limitless fleet', and had to be assured that the new projections were both precise and unlikely to be supplemented by unexpected demands for the construction of other

[118] Eberhard Rossler, *The U boat: the technical history of German submarine construction* (London 1975) pp.17–19

[119] GE Weir, 'Tirpitz, technology and building U-boats, 1897–1916' in *International History Review*, May 1984, p.178

[120] Jonathan Steinburg, *Yesterday's deterrent: Tirpitz and the birth of the German battlefleet* (London 1965) esp. pp.101, 120–3, 127

warships. Tirpitz thus developed a sharp sense of priorities. The Grand Admiral was well aware that he could not afford to give his opponents the opportunity to criticise him for extravagence; everything, including experiments with submarines, had to be subordinated to the Risk Theory if it was to carried through successfully [121]. "The consistency of his strategic doctrine and his devotion to the battleship became both a professional trademark and a factor supporting his political power," notes Gary Weir [122].

Asked to justify this position by pro-submarine elements in the Reichstag in May 1904, the Grand Admiral gave it as his opinion that "submarine will be of only secondary consideration in the formation of a navy, and they will bring about no great revolution, unless other technical difficulties are solved" [123]. He declared that Germany should wait another two years before obtaining and testing some boats [124]. In conversation with the British naval attache, Reginald Allerby, Tirpitz expressed a similar opinion: "He... believes that on service there will be few opportunities for a submarine to fire a torpedo with any effect," Allerby reported in March 1905. Tirpitz told the attache that "we are, of course, going to try them", but did "not anticipate great results." [125] The Imperial navy remained highly critical of the slightest technical inadequacy in foreign boats, drawing attention to the defects of its rivals' periscopes in tones that closely parallel the British strictures of the 1850s [126], and emphasising that submarines had not as yet shown themselves useful for anything more than coastal defence [127].

German reluctance to experiment with submarines was compounded by the Navy's refusal to commit government money to fund research. Tirpitz

[121] Ibid pp.67, 78, 128-30

[122] Weir op.cit. pp.175, 178

[123] Tirpitz quoted in 'Foreign naval progress and estimates 1904' (Germany), NID No.738, July 1904 p.74, Adm 231/41

[124] Quoted in Carl-Axel Gemzell, *Organization, conflict, innovation: a study of German naval strategic planning, 1888-1940* (Lund 1973) p.59

[125] Report of 4 March 1905, in 'Naval attaches' reports Berlin, 1906-1914', Ca2053, Naval Library

[126] Gemzell loc.cit.

[127] Report of 4 March 1905, in 'Naval attaches' reports Berlin, 1906-1914', Ca2053, Naval Library; Weir op.cit. p.180

insisted that private arms firms should bear the risk of developing new technology – as he had done in the late 1890s when several arms firms began to develop improved armour plating. The Admiral also encouraged private firms to design their own turbines when it would have been cheaper and quicker for the navy to build them under licence from Charles Parsons [128].

Several German arms firms did take an interest in submarine construction; the Howaldt Yard at Kiel had built boats to private designs in 1891 and 1897 [129], and in 1902 Germaniawerft, a Kiel shipyard owned by the Krupp armaments conglomerate, hired a Spanish submarine designer named RL d'Equevilley–Montjustin. D'Equevilley had been associated with Maxime Laubeuf in Paris, but sought work in Germany after his designs had been turned down by the French naval ministry in 1901. (There were persistent, but unfounded, rumours that he had fled with the plans for Laubeuf's latest submersible, the *Aigrette*.) Germaniawerft advised Krupp that it would be worth building an experimental boat to the Spaniard's design, and early in 1902 FA Krupp authorised construction of a 16–tonne prototype, *Forelle*. The submarine was completed by June 1903 and underwent six months of trials, during which period she was visited by both the Kaiser and his brother, Prince Heinrich. The latter, a senior naval officer, took part in a diving trial, and the head of the Torpedo Inspectorate, Rear Admiral Zeye, also looked over the boat on several occasions [130].

Germaniawerft was still unable to interest the Navy Office (RMA) – the department responsible for procurement – in submarine construction, and a projected 200–ton boat for the Dutch navy was never built. In 1904, however, the outbreak of the Russo–Japanese war brightened this gloomy outlook. Two Russian naval officers inspected the *Forelle* in March, and a month later the German firm secured a contract for three larger submarines; for good measure the Russians purchased *Forelle* as well. D'Equevilley produced the plans for three 205–ton boats of a double–hulled type influenced by Laubeuf's designs, but like the *Forelle*

[128] Weir op.cit. pp.176–8

[129] Rossler op.cit. pp.14–15

[130] Ibid pp.15–17

fitted with Korting paraffin engines for surface propulsion. Petrol engines were considered too dangerous; the designs were drawn up only months after serious petrol explosions had disabled the British submarines *A1* and *Holland No.2* and the American *Fulton*. The Germania submarines – *Karp*, *Karas* and *Kambala* – were completed in 1905 and taken over by the Russians, who sent them to the Black Sea.

By this time Tirpitz had sufficiently secured his political position to risk separating (after "special and particular reflections") the appropriations for torpedo boats and submarines from his Fleet Bill [131]. He was now free to order submarine boats, but still did so with extreme reluctance. However, the Grand Admiral's requirement that the preliminary work be done by the private arms industry at no cost to the state had been met, and it was increasingly clear that the modern submarine was a capable, seaworthy warship. "I refused to throw away money on submarines so long as they could only cruise in home waters," wrote Tirpitz in his memoirs. "As soon as seagoing boats were built, however, I was the first to encourage them on a large scale." [132]

Like Britain, Germany acquired its first submarines to assess the potential of underwater craft. It had comparatively little need to build boats for local defence – the ports on its short North Sea coastline were already well–protected by natural defences and costly fortifications [133] – and preferred to construct submarines capable of operating overseas. The Germans, like the British before them, thus entered the field of submarine construction almost on a par with their foreign rivals, who had only recently begun to build longer range submarines themselves.

The specifications set out for Germany's first boats were certainly rigorous enough to indicate a serious concern for seaworthiness. The RMA particularly required its submarines to cope with rough weather in the Bight and demanded safe engines – which meant using paraffin again [134]. The contract for *U1* (April 1904) went to Germaniawerft, but progress was slow,

[131] Tirpitz quoted in 'Foreign naval progress and estimates 1904' (Germany), NID No.738, July 1904 p.74, Adm 231/41

[132] Tirpitz, *My memoirs* (London 1919) p.138

[133] Report of 14 April 1910, in 'Naval attaches' reports Berlin, 1906–1914', Ca2053, Naval Library

[134] Rossler op.cit. pp.19–21

and in 1905 a plan calling for the construction of two single-hulled and six larger double-hulled boats was abandoned [135]. *U1* was essentially a copy of the *Karp*s, redesigned in places because the Russians had required a boat which could be broken up for transport overland; the fearsome U-boat flotillas of World War I were developed from a design produced by a Spaniard adapting French ideas to meet Russian specifications.

U1 was delayed both by her redesign and by the low building priority accorded to her; she was delivered (twelve months late) in December 1906, arousing little excitement. Her completion was not reported by the German naval press until October 1907 [136], and the director of the Germania yard informed the British naval attache that he regarded submarines "as mere toys", albeit toys with a future [137]. *U1* displaced 238/278 tons, had a range of 1,400 miles at 8 knots, a speed of 9/8.5 knots, and a single torpedo tube. But she managed a 587-mile round-trip in the North Sea shortly after commissioning; the first cruise by British submarines (1903) resulted in three of the five *Hollands* breaking down in the first few miles and none managing to circumnavigate the Isle of Wight [138].

The RMA now embarked on a programme designed to produce submarines with a 2,000 mile radius of action (1,000 miles at high speed), armed with 4 torpedo tubes and capable of 15/10.5 knots [139]. The order for *U2* went to the Danzig navy yard in March 1906; she was half as big again as *U1*, and her successors, *U3* and *U4*, displaced 414/502 tons. All these boats were essentially experimental models. Each was accorded low priority, and the *U2* (fitted with a new and troublesome Daimler paraffin engine in an attempt to meet the unrealistic specified surface speed) was in builder's hands for three years. *U5-U8* were not ordered until 1908; a year later, however, Admiral Zeye died and his successor, Lans, ordered four more boats and began to accelerate the programme.

Submarine construction estimates were doubled in 1908 and had

[135] Ibid p.17

[136] Holger Herwig, *'Luxury' fleet: the Imperial German Navy 1888-1918* (London 1980) p.87

[137] 'Germany: fleet, dockyards &c.' in 'Reports on naval affairs 1907', NID No.797, October 1907 p.46, Adm 231/46

[138] Reginald Bacon, *From 1900 onward* (London 1940) pp.64-5

[139] Jameson op.cit. p.99

doubled again by 1910. In 1906, Germany had planned to build only 20 submarines by 1920, but a new programme calling for six boats a year was introduced in 1912, with the aim of creating a 72-boat submarine service [140]. The Korting paraffin engine, which belched smoke and sparks and rendered German submarines visible for miles, even at night, was succeeded by diesels from August 1910; the first set was fitted to *U19*. The new engines drove the submarine at 15/9 knots and gave her a range of 7,600 miles at 8 knots, five times that of *U1*. Just as importantly, the German blast-injection design was less likely to make smoke than the Vickers solid-injection diesel [141]. U-boats were now taken more seriously by many naval men. The submarine school in Kiel was opened in 1912, and in 1913 an independent U-boat Inspectorate was established.

But Tirpitz remained unconvinced by the claims advanced for German submarines. The Grand Admiral was not unaware that many proponents of the new weapon were personally hostile to him, that the submarine provided a rallying point for opponents of his regime, and that some parliamentarians advocated submarine construction as a cheap but effective alternative to his big-ship programmes [142]. He allowed U-boats to participate in the 1909 manoeuvres only reluctantly, and prevented them from doing so in 1910 and 1911. In 1912, however, Tirpitz's absence from Berlin gave Admiral von Capelle the chance to include submarines in the fleet exercises once again. They scored some impressive successes in their 11 days at sea; only two of the 12 U-boats participating were ruled out of action, and that dozen were credited with sinking more ships than the 80 destroyers and torpedo boats present [143].

Tirpitz and his supporters refused to pay close attention to the results of the 1912 manoeuvres. In 1914, German naval operations plans still envisaged that the majority of available submarines would be stationed on a patrol line off the coast, ready to intercept the British Grand Fleet when it made its expected rush into the Bight. According to one long-term plan, 36 of Germany's 72 projected boats would make up the line, most of the

[140] 'Germany: war vessels 1914', NID No.896, proof copy in Jellicoe papers Add.Mss. 49003 fols. 113-17

[141] Rossler op.cit. pp.25-8; Herwig op.cit. p.88; Jameson op.cit. p.100

[142] Gemzell op.cit. pp.60-1, 95-7, 107

[143] Herwig op.cit. p.88; Jameson op.cit. p.101

remaining vessels forming a reserve so that 12 submarines could be relieved daily. A flotilla of 12 older U-boats were to protect the approaches to Kiel itself. So certain were the Germans that their enemies would institute a close blockade and offer the long-awaited decisive battle that there were only rudimentary plans for despatching U-boats to operate in the North Sea or off the British coast. A dozen submarines were to be allotted this task [144]. In 1914 Germany had no intention of sending U-boats further afield than the eastern seaboard of Great Britain, and none to use them as commerce destroyers [see section 6.3].

British naval intelligence found it difficult to guess what the Germans intended to do with their submarines; the Imperial Navy maintained a policy of strict secrecy, and the NID was forced to admit that "what little information has been obtainable has been very conflicting" [145]. Moreover the tardy development of effective German submarines gave the Royal Navy little opportunity to make an accurate assessment of their capabilities; diesel-powered U-boats, which were the only type suitable for covert operations off the British coast, were late into service, and so limited was the pre-war German training programme that (by peculiar chance) Weddingen's *U9* - which in September 1914 sank the three British *Bacchantes* of the 'Live bait squadron' stationed off the German coast - was the only U-boat ever to have practised firing salvoes of torpedoes and reloading the tubes while submerged [146]. All efforts were devoted to perfecting a 'submarine trap' for Royal Navy squadrons attempting to impose a close blockade [147].

[144] Rossler op.cit. pp.32-3

[145] 'Germany: war vessels 1914', Add.Mss. 49003 fol.113

[146] Testimony of Lt. Speiss of *U9*, quoted in Compton-Hall, *Submarine boats: the beginnings of underwater warfare* (London 1983) p.177

[147] Fisher to Jellicoe 30 November 1914, Add.Mss. 48990 fols.165-72; Prendergast & Gibson, *German submarine war 1914-1918* (London 1931) p.24

Planning

BRITISH NAVAL STRATEGY AND THE SUBMARINE, 1901–1914

British naval strategy and the submarine

In the pre–war period Imperial strategy depended, as it traditionally had, on the Royal Navy's ability to secure 'command of the sea'. Maritime supremacy was to be achieved either by winning a decisive battle against any likely combination of enemies, or by blockading rival fleets in their ports, thus securing supply lines, protecting commerce and preventing invasion [1]. British strength was measured in the Dreadnoughts that would dispute the decisive battle and in the cruiser squadrons to be deployed along trade lanes.

The development of naval rivalry with Germany – and the need to keep up with rapid technological change in gunnery and gun calibre, armour plate and engineering – distracted British attention from peripheral weapons such as the submarine. This, combined with general service ignorance of a weapon developed in a closed service, and the continued absence of an Admiralty staff with responsibility for planning, delayed a realistic strategic appraisal of the submarine. And since underwater craft had been developed for use against a dominant naval power rather than by

[1] The Navy's 1906 War Orders – which were "based on the possibility of war with France and Germany and Russia" – defined the duties of the British Channel fleet as, in order of priority: (1) to watch the enemy and if possible bring him to action; (2) attack enemy commerce–destroyers; (3) prevent invasion; (4) conduct combined operations with the army; (5) escort merchant shipping. Paper in Adm 116/900B cited in Bryan Ranft, ed., *Technological change and British naval policy 1869–1939* (London 1977) p.20

a power that already enjoyed command of the sea, it proved difficult for Britain to integrate the submarine into its naval strategy.

The submarine – and to a slightly lesser extent underwater weapons generally – fell outside the existing 'hierarchy of power' governing naval thinking. In the eighteenth and nineteenth centuries, a warship's importance was dictated by it size and broadside. It was generally accepted that a sloop or corvette could never hope to defeat a frigate, while no other class could stand against a line–of–battle ship. Close blockade of the enemy coast by a battlefleet was thus a practical policy, since it was impossible to harry a blockading fleet of battleships in the modern sense of the term.

The development of underwater weapons undermined the dominance of the battlefleet. War games and exercises demonstrated that constant fear of attack acted to restrict the actions of a fleet whenever it sailed into coastal waters occupied by submarines. The 'moral effect', to use a contemporary term, that underwater craft had on the strategy and tactics of enemy surface ships was considerable and bore little relation to the actual strength of the available flotillas. It was quickly recognised as the most significant contribution the submarine had to make to naval warfare.

Only a brave or foolhardy Admiral would run the risk of losing capital ships, on which the outcome of a naval war depended, by deliberately risking them in waters known to be infested with submarines. Bacon's six primitive boats, patrolling off Spithead in the manoeuvres of March 1904, "exercised an extraordinary restraining influence on the operations of the Home Fleet, besides inflicting most serious damage on their vessels." Surely, wrote the ICS, "*no other type of vessel has assumed so suddenly so vast an influence on the daytime operations of an enemy.*" [2] Hall emphasised "the great value of the moral effect of the submarine menace," which should be "constant and apparent off the German coast", and Keyes agreed that though Britain's overseas flotillas were weak in numbers, they could still play a decisive role because "the submarine menace to an enemy will be more moral than real." Late in 1914 he confided to his wife: "the submarine rules the sea to an extent I never thought possible – mainly by moral force – they can't be everywhere only one doesn't know where they aren't!" [3]

[2] Bacon to Admiralty 24 March 1904, Adm 1/7795

[3] Memo by Hall and Captain Thomas Crease, November 1914, Fisher papers FP 4309, Churchill College Cambridge; Keyes minute 10 May 1914, Keyes papers KP 4/5, British Library; Keyes to his wife 10 October 1914, KP 2/3

As the effective range of the latest submarines increased, it seemed that capital ships would be permanently at risk anywhere in the narrow seas. "We might," wrote Arthur Balfour, the former Prime Minister,

> "conceivably find ourselves surrounded by seas in which no enemy's battleship could lie, and which no enemy's troops could cross, but which would yet be as little under our control, for military or commercial purposes, as if we were the inferior maritime power. If there were any chance of such an extensive hypothesis being realised, we should not only be useless allies to any friendly power on the continent, but we should have the utmost difficulty in keeping ourselves alive." [4]

Even Fisher, who took a less pessimistic approach, accepted that "where two countries with about the same length of seaboard and an equal number of submarines face each other across a comparatively narrow sea (say 300 miles or less), the central waters between will clearly be equally dangerous to both." [5]

During the Great War, submarines, mines and torpedo flotillas did indeed have the decisive strategic effect of turning the southern half of the North Sea into a 'naval nomansland' in which the Germans constantly risked being caught in a sweep by the Grand Fleet, or attacked by patrolling underwater craft, but in which the British also ran considerable risks from German mines and torpedo flotillas. Since the Allies exercised effective command everywhere but in the southern half of the North Sea, the Baltic, the Adriatic and the Sea of Marmara, however, the main effect of the creation of these disputed waters was to severely limit the activities of the High Sea Fleet and effectively neutralise German naval power. The Fleet had to be preserved, to fight a decisive battle if one was offered on its terms, or as a bargaining counter in any peace talks. Only U-boats were able to operate outside the Baltic and North Sea [6].

Although the moral effect of the submarine was generally recognised,

[4] Balfour to Fisher 20 May 1913, FP 691

[5] Fisher paper 'The oil engine and the submarine', November 1913, FP 4293 p.6

[6] Cf. Geoffrey Till et al. *Maritime strategy and the nuclear age* (London 1982) pp.126-7; Marder, DSF II pp.42-9

her actual value in war was a matter of some dispute. The first boats had been acquired to act as trial horses in anti-submarine exercises, and the Admiralty had no immediate plans for employing them in any other capacity. The French, however, were using their boats as local defence vessels, and the British Holland boats, with their low freeboard and limited endurance, were also suitable only for employment in coastal waters.

The first reports on the submarine flotilla concluded that underwater craft had considerable potential in local defence. The "accepted function of submarine boats," wrote the umpires of the March 1904 manoeuvres, was to supplement coastal artillery, replace minefields and generally "to introduce a restraining care and vigilance on fleets acting at a considerable radius from a port." [7] In addition, submarines were valuable complements to existing torpedo flotillas, which were deadly at night but highly vulnerable to counter-attack in daylight. "Submarine boats are daylight craft only. At night-time, owing to the loss of light, their one great attribute, 'invisibility' due to submersion vanishes, the necessity for diving vanishes, and the more efficient destroyer under this protective cloak of darkness takes their place," noted Bacon. "This is the key in the use of submarine boats: submarines by day, destroyers by night." [8]

Invisibility, then, was a submarine's chief asset. Uniquely among warships of limited performance, she had the option of declining battle and was almost impervious to attack [see section 7]. Though the torpedo boat had been successfully countered by the classic orthodox response of turning a new weapon against itself, submarine could not fight submarine, and this virtual immunity from attack, combined with a frustrating elusiveness, overcame most of the limitations imposed by the poor seakeeping, poor endurance and low speed of early boats.

By 1905, proponents of the submarine had begun to suggest it could operate outside coastal waters. British flotillas, Fisher wrote, could "not only have their radius of action largely increased by towing, but they can be towed to the vicinity of the enemy, and almost up to striking distance, and be let go to fasten on to their prey without any visible sign of so doing, even in broad daylight!" They could be used to seal the Straits of Dover

[7] Umpires' report on the 1904 manoeuvres 28 March 1904, Adm 1/7795

[8] Bacon report 31 May 1903, Adm 1/7725; see also Fisher, undated paper (1904) in *Naval Necessities* I p.59, Adm 116/3092; Callaghan to Admiralty 3 August 1912, Adm 1/8269

and Gibraltar, and "with no class of weapons will audacity and offensive action be repaid so well as with submarines." [9]

Fisher's views were not yet widespread in the Navy, and many officers still doubted that submarines were anything more than harbour defence craft. In August 1905, for example, Admiral Ottley, secretary to the RN Design Commitee, observed:

> "The question as to whether it is worth while building a vessel which costs as much as a destroyer with less than half a destroyer's speed, and a third of its radius of action, and incomparably worse sea-keeping, appears to depend on the possibilities of extending such a vessel's tactical sphere of operations by towing. If submarines can be designed that could be safely and easily towed at high speeds and in any weather, without hampering a battle squadron, the tactical possibilities before them can hardly be over-rated, but unless this can be done the policy of spending large sums of money upon a type of vessel which has very narrow limitations is at least very questionable for a Power which is necessarily always obliged to aim at a wide maritime supremacy as we are." [10]

The tendency to think of submarines as 'weapons of the weaker power' – a phrase which, as Lord Sydenham observed, "easily passed into currency without examination" – was common in this period [11]. So was the inability of many naval officers to adapt existing strategic thought to accomodate underwater craft. The majority view was that submarines should help to win the decisive battle by accompanying the battle squadrons to sea [see section 8.2], or – if their seaworthiness prevented this – take the peripheral role of freeing other surface craft for operations with the fleet [12]. The Navy thus developed a tendency to think of the submarine as a substitute – for mines and torpedo boats at first, and later for destroyers and larger classes of vessel. Many of the specialist boats built during the

[9] Fisher paper 'Submarine boats' April 1905, in *Naval Necessities* II, Adm 116/3093 pp.446–53

[10] Ottley memo 4 August 1905, Adm 138/360A section 10, National Maritime Museum

[11] Lord Sydenham, '"The weapon of the weak"', *Naval Review* 1933 pp.47–53

[12] Cf. Admiral Sir Herbert Richmond's exposition in '"The weapon of the weak"', RUSI Jo. August 1932 pp.497–503

war aimed to combine the best features of a surface vessel – destroyer, monitor or minelayer – with the submarine's 'great attribute', invisibility. What now appear to be the type's main roles – covert patrol and commerce destruction – were not the bold inventions of some desk–bound strategist, but discoveries made as practical experience was gained.

By 1912 the rapid development of the submarine had made it the destroyer's equal in many respects. John de Robeck, the Admiral of Patrols, noted that "each year sees the destroyer and the submarine approach each other both in character of design and in the nature of their duties," and Callaghan, the CinC, judged that "in some respects they are already superior to the destroyer, viz. radius of action, immunity from detection and from damage from gunfire, and number of torpedoes carried." [13] This suggested that, as well as being towed and scouted for by destroyers as British flotillas were from 1911, the submarine could substitute for the TBD in some circumstances – freeing British destroyers to act with the fleet. An Operations Division report of August 1912 observed:

> "There can be no doubt that the development of the submarine is tending to modify the function of the destroyer. Until recently it had been considered that these functions are, firstly, to operate against hostile torpedo craft, and, secondly, to deliver torpedo attacks on larger ships. The submarine is rapidly assuming the latter function, but it cannot assume the former."

The 1912 manoeuvres were used to test tactics for screening a battlefleet with destroyers, and by 1914 most British TBDs had been switched from offensive duties with the torpedo flotillas – where they had orders to to attack enemy ships – and attached to the battlefleet. Their function, the Operations Division report continued, was

> "to accompany the fleet to (1) assist in repelling attacks by destroyers and submarines of foreign powers, (2) to attack an enemy fleet during or after action, (3) for defence against the submarine, and (4) for use as minesweepers." [14]

[13] De Robeck to Admiralty 17 June 1912, Adm 1/8273; 'General remarks by CinC on manoeuvres' 5 August 1912, Adm 1/8269

[14] George Hope memo 23 August 1912, Adm 1/8269; Marder, DSF I pp.329, 335–6

Fear of submarine and enemy destroyer attack was such that the Grand Fleet quickly became obsessed with the need for the strongest possible destroyer screen. Jellicoe expressed the greatest possible reluctance to go to sea without a minimum screen of 40 TBDs for the battle squadrons alone. Not only did this deprive British anti-submarine patrols of modern torpedo craft, which they sorely needed; it also limited the seagoing radius of action of the fleet itself to that of its TBDs, about 1,800 miles, and made its commanders unwilling to manoeuvre in heavy weather, when torpedo flotillas were unable to accompany the capital ships [15]. The threat of attack by underwater weapons against which he had little defence considerably increased Jellicoe's caution. In a paper written in October 1914, he declared he would not follow the enemy if he turned away during an action (as happened at Jutland) because the intention was probably to draw the Grand Fleet into a mine and submarine trap. It was, wrote the CinC, "quite within the bounds of possibility that half our battlefleet might be disabled by under-water attack before the guns opened fire at all, if a false move is made." Furthermore the best safeguard against submarines "will consist in moving the battlefleet at very high speed before deployment takes place or the gun action commences. This will take us off the ground on which the enemy desires to fight but it may, of course, result in his refusal to follow me." [16] Underwater craft thus significantly limited the chance of either side winning a decisive victory at sea during the Great War.

In the last years of peace the Admiralty did develop a real understanding of the submarine's potential, and by 1913 the RN possessed a comparatively sophisticated scheme for using submarines offensively. This was due in part to the development of an Admiralty War Staff with responsibility for formulating strategy.

As early as 1908 the 'war staff' – then an *ad hoc* group of senior officers and representatives from the Naval Intelligence Department – had suggested stationing submarines off an enemy coast [see section 6.3]. More formal consideration of Britain's strategic needs began in 1909 with the establishment of the Navy War Council (converted into an Admiralty War Staff in January 1912) [17], and by July 1913 – with the experience of

[15] Cf. Marder, DSF II pp.75, 422; DSF V pp.300-02

[16] Jellicoe to Admiralty 30 October 1914, Jellicoe papers Add.Mss. 49012 fols. 23-5

[17] Marder, DSF I pp.247-8, 265-6

two more or less realistic sets of manoeuvres to guide it – the Staff had turned its attention to the submarine.

In the opinion of Henry Jackson, the Chief of Staff, "the operations carried out in last year's manoeuvres [1912] demonstrated practically that the submarine has progressed beyond the stage of a local defence craft." The latest overseas submarines, he wrote, "are capable of more offensive action in war at a distance from their bases than was anticipated a few years ago; in fact a great potential appears to lie in this direction and the policy of further developments in design to meet war requirements is fully concurred in by the War Staff." [18] As for coast defence, "the best form of protection against all kinds of attack may ultimately be found in strong submarine patrols, with supports of military forces and guns on shore... No great degree of fixed defences is required as the submarines should suffice to keep the enemy's important armoured units at a distance." [19]

The Admiralty's last-minute recognition of the full potential of submarine warfare had significant consequences for British strategy in general. The submarine's performance in 1912-14 was all the more shocking for being unexpected. The development of an efficient overseas boat finally put an end to the old policy of close blockade, which had been in difficulties for several years. In its place, the Admiralty adopted the intermediate blockade and, from July 1914, the distant blockade, which envisaged cutting German forces off from the Atlantic in the Channel and between the Shetlands and Norway. The change of policy wrong-footed German strategists, who had confidently expected the Grand Fleet to steam into the Heligoland Bight on the first day of war, ready to institute a close blockade. This, it was anticipated, would give German mines and torpedo flotillas the opportunity to reduce British naval strength to the point where the High Sea Fleet could challenge the RN in a decisive battle. Instead the HSF was reduced to impotence by its inability to catch and destroy individual squadrons of the Grand Fleet.

The development of underwater weapons thus forced a reassessment of German naval strategy and led directly to the declaration of an unrestricted submarine war against commerce. This the Royal Navy had failed in its turn to consider before 1914. It was contrary to international law, and the

[18] Jackson minute 18 July 1913, D'Eyncourt papers DEY 31, National Maritime Museum

[19] War Staff commentary on Callaghan paper 'Remarks on North Sea strategy', 29 September 1913, Adm 116/1214

RN could not believe its enemies would be so desperate or despicable as to resort to such measures [see section 6.3].

The War Staff's comments sum up British submarine policy in the last months of peace. Submarines could be used offensively and defensively. They were the best available weapons for coastal work, and now offered the RN the ability to re-establish a blockade in hostile waters. It was also possible to look some way into the future and make a case for the development of much larger boats. The First Lord, Churchill, argued that the Navy should have three types of submarine: coastals, to act as partial substitutes for land based local defences; overseas boats, "to take the place of the TBDs and the inshore squadron", and "the ocean submarine", a "decisive weapon of battle ...[that]... must count as a partial substitution of battleship strength." [20]

Churchill's argument was not new. Fisher, one of the earliest and most enthusiastic proponents of the submarine, had for years believed that underwater craft would render the old-fashioned battleship obsolete. In July 1904 he had suggested that the construction of capital ships should be suspended on the grounds that "a battle fleet is no protection to anything, or any operation, during the dark hours, and in certain waters *is no protection in daytime*, because of the submarine. Hence what is the use of battleships as we have hitherto known them? *None!* Their one and only function – that of ultimate security of defence – is gone – lost!" [21] His advocacy of the battlecruiser – fast enough to elude submarine attack – was based in part on these conclusions [22].

The idea that submarines would replace the battleship – with all the radical implications for British strategy that suggested – was still potent enough to arouse considerable national controversy in June 1914. The proposal originated, so far as the public was concerned, in a letter to *The Times* from the well-known gunnery expert Admiral Sir Percy Scott – one of the less likely submarine enthusiasts thrown up by the Royal Navy. Scott's thesis, that "submarines and aeroplanes have entirely revolutionized naval warfare" and "no fleet can hide itself from the aeroplane eye and

[20] Churchill minute 20 July 1913, DEY 31

[21] Fisher paper 'Admiralty House, Portsmouth', July 1904, quoted in Jon Sumida, *In defence of naval supremacy: finance, technology and British naval policy 1889–1914* (Boston 1989) p.52

[22] Ibid pp.52–5

the submarine can deliver a deadly attack even in broad daylight" led him to some clearly–stated conclusions:

> "Under these circumstances I can see no use for battleships and very little chance of much employment for fast cruisers. The Navy will be entirely changed; naval officers will no longer live on the sea, but either above it or under it...
>
> What we require is an enormous fleet of submarines, airships and aeroplanes, and a few fast cruisers... I do not think the importance of submarines has been fully recognized, neither do I think that it is been realized how completely their advent has revolutionized naval warfare. In my opinion, as the motor vehicle has driven the horse from the road, so has the submarine driven the battleship from the sea." [23]

Service writers hurried to counter Scott's arguments. 'A Naval Officer' pointed out – correctly – that they were broadly similar to the *jeune ecole* views prevalent in France in the 1880s, which had caused "complete confusion, the displacement of France as a high naval Power, and the reversion to the policy of building battleships and cruisers." [24] The Navy League decried them as "calculated to do serious harm to the cause of the maintainance of British supremacy at sea" [25], and Lord Sydenham described the Admiral's letter as "rambling and unconvincing" [26]. Even Bacon urged caution and suggested that Scott was under–estimating the fallibility of the young officers in command of submarines [27].

But Scott had his supporters. SS Hall had already argued that "as the submarine grows and extends its activities the surface vessel... will be driven out of existence," [28] and his views appear to have influenced

[23] Percy Scott, 'Large ships or small: the needs of Great Britain at Sea', *Times* 5 June 1914 p.9 col.f – p.10 col.a. See also Peter Padfield, *Aim straight: a biography of Admiral Sir Percy Scott* (London 1968) pp.223–7

[24] 'Limitations of the submarine', *Times* 6 June 1914 p.10 col.a

[25] 'Statement by the Secretary of the Navy League', *Times* 6 June 1914 p.9 col.f

[26] Lord Sydenham, 'The apotheosis of the submarine', *Times* 8 June 1914 p.50 col.a

[27] Bacon, 'Surface ships or submarines?', *Times* 15 June 1914 p.6 col.a

[28] Hall paper 'On the general question' 17 May 1913, FP 4287

Fisher, who had concluded by the last months of 1915 that even the battlecruiser was obsolete. "The greatest possible speed with the biggest practicable gun was up until the time of the aircraft the acme of sea fighting. Now there is only one word – submersible." [29]

The rapidity of technological change influenced naval strategy in a variety of ways. It should have promoted strategic thought (and in fact eventually did so) as it became obvious that existing principles no longer applied to the changing fleet. However, it also meant that many of the Royal Navy's most able officers devoted their time to solving technical problems. The RN lacked the experience of full–scale modern warfare that might have demonstrated the real potential of the submarine.

Scott, Fisher and Hall under–estimated the staying power of the capital ship. Not a single Dreadnought was sunk by submarine during the Great War, and the commanders of underwater craft discovered that their submerged speed was insufficient, their torpedoes unreliable and their quarries considerably more elusive than had been anticipated. Their assessment was typical of a service that was technology–led rather than strategy–led: blinded by the technical specifications of the latest submarines, they drew inaccurate conclusions from accurate figures.

The American army confronted similar problems in attempting to develop an equally revolutionary weapon – the machine gun – in the years of retrenchment following the Civil War. It lacked a staff to evaluate the guns it was offered, and was burdened by regulations that limited the participation of line officers in the testing and development of new weapons [30]. Assessment was further hindered by general ignorance of the capabilities of the new weapon, and army procedure also encouraged the creation of epigrammatic slogans – very similar to the 'weapon of the weak' tag applied to the submarine – that obstructed further original thought. The machine gun was labelled as a weapon suitable for the defence of fixed positions, or (in the British army) as a 'weapon of opportunity', rather than as a weapon with offensive potential [31].

The problems encountered by the Royal Navy as it attempted to

[29] Quoted in Sumida, op.cit. p.318

[30] David Armstrong, *Bullets and bureaucrats: the machine gun and the United States Army 1861–1916* (Westport, Connecticut 1982) pp.55, 73–4

[31] Ibid pp.89, 114, 151–3; Tim Travers, *The killing ground: the British Army, the Western Front and the emergence of modern warfare 1900–1918* (London 1987) p.70

develop strategy and tactics for the submarine find perhaps their most exact parallel, however, in the early military history of the aeroplane. The US Army was as slow to acquire aircraft as the RN was to sign a contract for Holland submarines, ordering its first planes in February 1908, less than 10 years before the US entered World War I but more than four years after the Wright brothers – whose had approached the military authorities in January 1905 – first flew [32]. In the subsequent rush to develop techology and strategy simultaneously, writes IB Holley, "the problem of aircraft development was tremendously complicated by the prevailing uncertainty regarding tactical objectives; they were never clearly defined before the US entered the European conflict. Unlike most weapons, the airplane was capable of performing several tactical functions. Each of these required a specialised line of technical development." The US Army, he suggests, failed to determine in advance what its aircraft were intended to do, allowing the capabilities of existing types to dictate tactics. Formulation of aerial doctrine became the province of technical men officially charged with making nothing but technical decisions. The air branch thus became technology rather than strategy driven [33].

The multi–purpose British submarine was a potentially a similarly versatile weapon. But by placing it in the hands of technical men who had no formal strategic training, the Admiralty delayed modification of the original doctrine – itself determined largely by the technical shortcomings of the original Holland boats – that underwater craft were suitable only for coastal defence. Bacon, Lees and Hall thought of all their designs as coastal boats, and Keyes, in 1911, was the first to use the expression 'overseas submarine' [see section 3.2].

To summarise: the submarine was – as Tim Travers remarks of the machine gun in the British army – "readily accepted, but the problems of integration into the human side of the equation had not been thought through." Once the Royal Navy had acquired the novel, imperfect, but potentially revolutionary new weapon, it directed it into acceptable and traditional roles. The problem was not getting the submarine accepted as a

[32] IB Holley, *Ideas and weapons: exploitation of the aerial weapon in the United States during World War I; a study in the relationship of technological advance, military doctrine, and the development of weapons* (Hamden, Connecticut 1971) pp.26–9

[33] Ibid pp.32, 39–40, 55–60

piece of technology, but what was done with it [34].

Indeed, Travers's model of the military scheme for assessing new technology before and during World War I – which he uses to evaluate the army's development of the machine gun and the tank – also applies broadly to the submarine. "The following evolution is seen to take place," he writes.

> "(1) the invention and introduction of the new piece of technology, with some resistance from the higher staff levels, and some arm resistance; (2) after a certain period of time, ready acceptance of the technology, especially at middle and lower levels of the officer corps; but then an important stage occurs, (3) a corresponding reluctance to think through the logic of the new weapon, and therefore a tendency to relegate the weapon to traditional, peripheral or subordinate roles. At this important stage (4) there emerge small but vigorous groups of supporters and opponents, with a large middle group of mostly non-thinkers; but (5) from the small support group there emerge further one or two individuals who articulate appropriate tactics for the new weapon, which eventually enable the weapon to assume a semi-autonomous or separate role according to its own logic, and which firmly integrate the weapon into the tactical system." [35]

The submarine, like the tank and the machine gun, was an unwelcome innovation. Officers of the surface fleet found it difficult to accept its considerable potential, and though years of ever-improving performances in fleet exercises did persuade the majority, by 1914, that underwater craft could be formidable in certain circumstances, submarines were still seen largely as peripheral weapons best suited to coastal defence and perhaps scouting. They were not yet fast or seaworthy enough to operate with the fleet, and – because they could not be part of the collectivity – they suggested independence and thus, to some, lack of dependability. Above all, they had never proved themselves in war. The Navy, in accepting submarines as a necessary evil, did little to solve the riddle that they posed, and from which practically every strategist shied away: "Britannia may rule the waves, but who will rule above them, and below?" [36]

[34] Travers op.cit. pp.62–3

[35] Ibid p.76

[36] Colonel Charles a Court Repington (military correspondent of *The Times*), 'New wars ▶

British coast defence policy to 1903

The Royal Navy was Britain's chief bastion against the threat of invasion, and as such was responsible for defending the coast. The Admiralty believed, however, that an invasion fleet was best met and destroyed at sea, long before it sighted land. Unlike the Russian and American navies, therefore, the RN showed little interest in developing squadrons of short–range local defence vessels.

The Royal Navy largely abdicated responsibility for inshore coast defence in the late 1800s. The 1882 Carnarvon Commission on naval efficiency reported: "The Royal Navy is not maintained for the purpose of affording direct local protection to seaports and harbours... Our seaports must rely for their immediate defences on local means, leaving the Navy free to act at sea." [37] Artillery and engineer units were made responsible for fortifications and boom defences respectively. In April 1878 it was agreed that the War Office would also assume control of mines and mining, and from 1886 the army provided its own mining boats and equipment [38]. "The arrangement by which the War Office defends our ports, leaving us to do our duty at sea, is the basis of our War Policy," declared the DNI, Battenburg, in 1903 [39].

Wise though it was, RN 'War Policy' was open to misinterpretation. The immense difficulty of mounting an invasion in the face of British naval supremacy was an awkward concept for the public to grasp, since the vessels protecting them were scattered across the Seven Seas. Moreover the RN's ability to prevent invasion had not been tested since the Napoleonic wars. In those days an invader's dependence on favourable winds made it easy to predict which moment would be chosen for an attack, but the development of steam propulsion returned the initiative to Britain's enemies. Steam made it possible to elude a British blockade and send an invasion

◀ for old', *Blackwood's Magazine* June 1910, p.896. The chief reservation the British naval strategist Julian Corbett had about the submarine was its lack of experience in real warfare. See *Some principles of maritime strategy* (London 1911) p.233

[37] Carnarvon Commission, second report (1882) para 15, cited in 'Memorandum on the responsibility of the War Department for provision of land defences against attack by torpedo boats', November 1903, Cab 3/1/2A

[38] War Office memo 'Submarine defences of ports' nd (?1903), Adm 1/7717; see also Clarke memo nd (?1888), WO 33/46 p.221

[39] Battenburg minute 26 February 1903, Adm 1/7717

fleet across the English Channel in short order. In 1845 Palmerston precipitated an invasion scare with his declaration that 'steam has bridged the Channel' [40].

The completion of the revolutionary French battleship *Gloire* caused a similar panic in 1859. 160,000 militiamen were hastily called to arms and parliament voted £12 million for a chain of coastal fortifications – 'Palmerston's follies'. Confidence in the Royal Navy's ability to prevent invasion was again dented by the Franco–Russian entente and the 'Truth about the Navy' scare twenty years later. In 1888 there was another significant invasion panic, fuelled by the disquieting results of the annual manoeuvres and the bellicose proclamations of the *jeune ecole* on the subject of coastal bombardment. This scare in turn helped prompt a major five–year building programme paid for with funds voted under the Naval Defence Act of 1889. Public interest in invasion topics peaked in the 1890s as newspaper proprietors discovered that war scares sold papers and exploited this new market with great gusto. The 'invasion bogey' remained a hotly–debated topic of conversation [41].

The general quality of the debate was poor. The public was largely uninformed. War Office planning began with the assumption that invasion was possible [42], while the Royal Navy insisted that it was not. Certainly none of Britain's potential enemies had realistic plans for such a project – "the idea of an invasion of England is insane," wrote the German Chancellor, Hohenlohe – although France hoped to use the threat of landings to tie British military and naval forces to their own shores [43]. But the RN had no way of proving its case. Its understanding of the problem was largely instinctive.

The ensuing dispute between the navalist 'Blue Water school' and those who believed an invasion could successfully be launched as a 'Bolt from the

[40] See James Baxter, *The introduction of the ironclad warship* (Cambridge, Mass.) pp.65–8

[41] Marder, ABSP pp.67–81; Howard Moon, *The invasion of the United Kingdom: public controversy and official planning 1888–1918* (University of London Ph.D. 1968) vol.I pp.7–126

[42] Moon op.cit. I, 81–6

[43] Hohenlohe quoted in Paul Kennedy, ed, *The war plans of the Great Powers, 1880–1914*, London 1985 p.176; French plans in Moon op.cit. I, 123 and Theodore Ropp, *The development of a modern navy: France 1871–1904*, University of Harvard Ph.D. 1937 pp.531–3

Blue' (the 'Blue funk' school, as they were derisively known in Admiralty circles) has been dealt with elsewhere [44]. The RN understood, however, that naval strength was measured in battleships and cruisers, not coast–defence vessels. The Navy's significance as a versatile instrument of foreign policy, and thus its position as the Senior Service, depended on its mobility.

It was this consideration that underpinned the RN's obsession with offensive warfare in the face of evidence that underwater weapons and the limited endurance of the steam navy rendered its strategy largely untenable. In consequence, the Admiralty was reasonably content to leave the coastal defences of the British Isles in the hands of the army.

The submarine and the mine

Britain's coast defence forces had to guard against three significant threats: invasion, a raid to disrupt Britain's war effort, and a surprise attack on the fleet at anchor.

The invasion question was kept alive by a succession of Defence Committee and CID reports on the problem (1903, 1907–08 and 1913–14) which, though they found in favour of the 'Blue Water' school, suggested that a strong force of torpedo craft was needed to deter an enemy [45]. Local defence flotillas and strong land emplacements would be needed to deal with a surprise attack on the British fleet – an attractive prospect to a weaker enemy – and, in addition, British naval forces would almost certainly be involved in any attempt to intercept a raiding force, particularly if the landing was made at one of the defended ports.

The difficulties of landing troops on an open beach, where there were no facilities to speed up disembarkation and transports were vulnerable to attack, suggested that an invader might try to seize control of a British harbour. Landing from a jetty was a rapid process – in the 1913 British

[44] In addition to the sources cited in notes 41–43, see AJA Morris, *The scaremongers: advocacy of war and rearmament 1896–1914*, London 1984, esp. part 2

[45] 'Possibility of invasion during temporary loss of command of the sea' March 1903, Cab 3/1/11A; 'Invasion: report of a sub–committee appointed by the Prime Minister to consider the question of overseas attack' 22 October 1908, Cab 3/2/44A; 'Attack on the British Isles from overseas' 15 April 1914, Cab 3/2/62A

manoeuvres 1,000 men were put ashore at Immingham, on the Humber, in 15 minutes – and the 1914 invasion committee remarked that a fleet that had crushed the immediate defences and anchored in port was almost safe from counter attacks by other torpedo flotillas. Furthermore the majority of British harbours, particularly those on the east coast, were not heavily defended. In 1900 there was only one first class naval base – Chatham – between Dover and Cape Wrath. Construction of a second base, at Rosyth, began in 1903, but work on the dockyards there proceeded so slowly that they had not been completed by 1914. In 1912 Cromerty was designated a second class base – capable of dealing with every contingency but major repairs – and Dover and Harwich were listed as third class ports ('war anchorages', with minimal resources), but the Thames, Humber, Tees, Tay and Tyne rivers, plus the towns of Hartlepool and Aberdeen, were listed as no more than 'fortified commercial ports'. Their defences were designed to deter torpedo boats and unarmoured cruisers, but not to stand up to an attack by battleships [46].

The typical scheme of defence for a port was based around coastal artillery mounted in forts. Harbour entrances were defended against torpedo boats and blockships by booms, searchlights and quick firing guns, and fields of observation mines (fired electrically by observers on the shore) covered the approaches to a harbour. In a fully–developed defence system, minefields and coast artillery provided mutual cover for each other, the theory being that mines could not be swept until the guns were silenced, which in turn was not possible until all underwater defences had been neutralised, thus allowing attacking ships to close the range decisively.

The superiority of forts engaged in a duel with warships was generally accepted in the nineteenth century. The difficulty of suppressing fire from even poorly manned and equipped fortifications was demonstrated on several occasions, notably the bombardment of Alexandria in 1882. From the naval point of view, the problem was that only a direct hit on the guns could put a shore battery out of action, while a ship was vulnerable to shell–fire along her whole length. The difficulty of spotting the fall of shot on land was also far greater than at sea, where water–spouts gave direction to the gunners.

[46] Arthur Vyvyan paper 'Remarks on the 1913 manoeuvres' nd (?1913), Adm 116/1169; 'Report and proceedings of the standing sub–committee on the North East coast defences' 29 November 1912, Cab 3/2/54A

By 1903–04, however, improvements in the range and accuracy of naval gunnery suggested that modern warships could stand off outside an observation minefield and reduce fortifications by long–range fire. The Admiralty admitted that "it will probably be found that nearly all our existing minefields are insufficient in extent" [47], and it became obvious that new defences effective at least four or five miles from the coast were required.

The increased threat of attack made the Royal Navy anxious to reacquire some measure of control over coastal defence and encouraged it to promote the submarine as a weapon that could replace the mine in British strategy. The Admiralty recognised that a surprise attack could have a devastating effect on a navy whose warships now spent more time in port, refitting and refuelling, than they once had. Fisher's nucleus crew system called for much of the fleet to be kept in reserve, and the drive to cut back overseas commitments further added to number of ships stationed in home waters. In addition, the Japanese attack on Port Arthur (8 February 1904), in which three battleships were disabled by torpedoes and the Russian Pacific Fleet put on the defensive for the duration of the Far Eastern war, showed how vulnerable a major port could be to surprise attack. The Royal Navy, which was not itself averse to the idea of 'Copenhagening' the rapidly–growing German fleet, took the threat of an enemy assault very seriously in the pre–war period, and the Admiralty felt uneasy that so much depended on defences over which it had so little control.

Naval officers had little faith in the army's ability to work the coast defences efficiently. The services rarely co–operated amicably; the army's control over the procurement of naval ordnance caused such friction that the Admiralty insisted, from 1907, on the RN's right to develop its own heavy artillery, and naval manoeuvres consistently showed that army gunners had difficulty distinguishing friendly warships from foe [48]. Even the War Office was inclined to admit that military control of 'aquatics', the naval aspects of local defence, was an anomaly "injurious to both services, and likely to tend to great confusion in time of war." [49] The engineer

[47] Admiralty paper 'Submarine mines' October 1904, Cab 38/6/104

[48] Cf. the example of the 1904 Milford Haven manoeuvres, 'Great Britain: torpedo craft manoeuvres 1904', NID No.754, December 1904, Adm 231/43

[49] Arnold–Forster to Lyttleton (CGS) 19 May 1904, Add.Mss. 50308 fols.4–5

mining specialist Colonel Ruck acknowledged "a strong undercurrent of naval opinion directed against both the form and the strength of military defences," which he thought had been "shown chiefly in connection with the submarine defences, which have been looked upon with a certain amount of distrust by many naval officers." [50]

The disputes thrown up by mining were typical of those that bedevilled naval–military relations in the field of coast defence. In France, as John Walser points out, "the entire issue of responsibility for coastal defense was clouded in the debris of successive and often contradictory decrees", and the *Marine Francaise* – while asserting that its fleets provided the best defence against enemy assaults – was reluctant to allow the army control of fortifications without assurances that military personnel would be trained in warship recognition and naval affairs. The French army, on the other hand, expected the coast defence network to provide a reserve of men and artillery for its continental campaigns [51]. In the United States, as we have seen, the same dispute was complicated by the army artillery corps' acceptance of responsibility for mining and its endorsement of a naval weapon, the Lake submarine, for mine maintenance [52].

The RN's determination to resume control over some aspects of coast defence was reinforced by Admiral Fisher's personal distrust of the land service and his suspicion that a worried public might support the creation of an army large enough to repel a full–scale invasion – with disastrous consequences for the Navy Estimates [53]. In his private papers, and in his dealings with the Committee of Imperial Defence, Fisher liked to give the impression that the submarine was a sure guarantee against invasion. Such a project was now "absolutely precluded," he insisted [54], and the strength of the army could be safely reduced by 300,000 men [55].

"It affects the army," the Sea Lord concluded in one famous passage,

"because imagine even one submarine boat with a flock of transports

[50] Ruck memo 29 January 1904, Add.Mss. 50318 fols.189–90

[51] John Walser, *France's search for a battlefleet: French naval policy 1898–1914* (unpublished PhD thesis, University of North Carolina (Chapel Hill) 1976) pp.95–6, 391

[52] For other examples of military demarcation disputes, see Armstrong op.cit. pp.55–6, 61–8, 83–6; Travers op.cit. pp.62–78; Holley op.cit. pp.68–70

[53] Ruddock Mackay, *Fisher of Kilverstone* (Oxford 1973) pp.285–304, 331–4

[54] Fisher to Sandars nd (?late 1903), Balfour papers Add.Mss. 49710 fol.55

[55] Mackay op.cit. p.299

in sight loaded each with some two or three thousand troops. Imagine the effect of one such transport going to the bottom in a few seconds with its living freight. Even the bare thought makes invasion impossible! Fancy, 100,000 helpless, huddled up troops in frightened transports with those invisible demons known to be near.

"Death near–momentarily–sudden–awful–invisible–unavoidable! Nothing conceivable more demoralising!... How could there possibly be any bombardment of any place (fortified or not) with submarine boats present, or even suspected of being present?" [56]

Fisher worked hard persuade Britain's decision–makers of his case, and was delighted when King Edward, emboldened by the prospects for naval coast defence, suggested the country should "spend money on submarines etc but don't waste money on an armed mob." [57]

The RN's distrust of military coast defence was further compounded by an absolute distrust of mine warfare. Although more than 50 British ports at home and overseas were provided with mine defences in 1903 [58], the RN opposed suggestions that more and larger minefields were needed, arguing they were dangerous and expensive luxuries. "Admiralty practice of late years," noted Fisher, "has been to induce the military to shift these fields, more and more, into waters in which they can never be used, presumably to prevent their actual use and attendant damage to our own fleet." [59] The Navy's dislike of contact mines – effective though they were at some distance from the coast – was even greater, since they were indiscriminate (and thus probably illegal) weapons, difficult to maintain when exposed to tides and currents, useless to a Power enjoying command of the sea, and a threat to the mobility of the fleet [60].

The Admiralty was fully prepared to over–state its case to secure the abolition of Britain's mine defences. It criticised observation minefields on

[56] Fisher paper 'Invasion and submarines' nd (December 1903) FP 4940

[57] Ponsonby to Fisher 9 October 1907, FP 259

[58] Selborne to Arnold–Forster 14 November 1903, Arnold–Forster papers Add.Mss. 50308 fols.9–10. For details of British and colonial defended ports, see 'Defence of naval and commercial harbours – memorandum by Lord Selborne' 27 July 1905, Cab 4/1/63B

[59] Fisher paper 'Defence of naval arsenals' nd (1904) in *Naval Necessities* I, 92, Adm 116/3092

[60] Marder, DSF I pp.328–9, DSF II pp.70–1

the grounds that they were a danger to shipping, even though they could not obstruct the most heavily–used channels and electrically–fired mines had never accidentally sunk a friendly ship. HO Arnold–Forster, the new Secretary of State for War, charged that naval delegates had misled civilian members of the CID by deliberately confusing observation mines with the more dangerous mechanical 'contact' variety [61]. The War Office also disputed the Admiralty's claim that submarine flotillas would be cheaper to run than the RE coast defence establishment. Although the coast defence estimates amounted to £550,000 each year, the Director of Military Operations, Major General Grierson, pointed out that only £125,000 of that sum was spent on mines [62]. Submarines, at £40,000 a boat, were much more expensive [63]. In November 1904 the Admiralty tacitly admitted it had exaggerated by agreeing to describe minefields as 'inconvenient' rather than 'dangerous' in future [64].

Although the Admiralty had developed a genuine enthusiasm for the submarine's potential as a coast defence weapon, therefore, it promoted underwater craft in the mid–1900s primarily because it wanted the government to abolish the mine and return responsibility for inshore defence to the Navy. The submarine was a genuine naval weapon in a way that the mine was not. Bacon noted that his boats had "uses in defence by working offensively." [65] Battenburg, the Director of Naval Intelligence, agreed: "It is thought that submarine boats may still take the place of the Royal Engineer mines and yet not be tied down to a particular port on our coasts," he wrote [66]. In short, torpedo craft justified RN interest in the nautical aspects of coast defence because, according to Lord Walter Kerr,

[61] Arnold–Forster diary 22, 23 + 26 November 1904, Add.Mss. 50341; diary entry 12 December 1904, Add.Mss. 50342; Arnold–Forster to Balfour 30 November 1904, Add.Mss. 50318 fols.184–5

[62] Admiralty paper 'Submarine mines' October 1904, Cab 4/1/40B; 'Submarine mine defences: dissent by Major General Grierson' 24 November 1904, Cab 38/6/11

[63] Cf. figures in 'Report of a conference between Admiralty and War Office representatives to consider the future functions of submarine mines in war' December 1903, section 2, Adm 1/7717

[64] Arnold–Forster diary 25 November 1904, Add.Mss. 50341

[65] Bacon report 16 January 1904, Adm 1/7719

[66] Battenburg minute 26 February 1903, Adm 1/7717. See also Durnford minute 24 December 1903 to Bacon report, ibid; Ballard minute 27 November 1912 to 'Establishment of shore depots for destroyer and submarine flotillas', Adm 1/8269

"in no case can the submarine, in my opinion, be classified as 'fixed defences'. They are free to move, up to the extent of their limitations." [67]

By 1903–04, therefore, the Navy had decided that the submarine was more than simply a harbour defence vessel. Fisher claimed that "submarine boats may in a broad sense be looked on as extending the defence of a port enormously beyond the range of gunfire, and as linking the defences of ports along ranges of coast now locally defended" [68], and Bacon deployed a similar argument, again emphasising the submarine's range: "By laying mines, and trusting to them for defence, money is being merely locked in fixed defences which have no mobility," he wrote. "Such a defence can merely be a *spotty* defence, and can never provide a protected belt around our island... If boats of a fair speed were worked from suitable small harbours, a complete protection would be provided." [69] The submarine was a formidable weapon on her own ground, the RN argued. Invisibility gave her the 'moral effect' of the mine, she could exercise discretion in picking a target, and, most significantly, she had (limited) offensive potential. "If submarine boats can do more efficiently and economically the work now done by the large submarine mining establishment of the Army," concluded Lord Selborne, "then submarine boats *must* replace submarine mines." [70].

Submarines and the Admiralty scheme of coast defence

The Navy formally requested the abolition of Britain's mine defences at a joint army–navy conference held in December 1903. Mines, the RN delegates argued, were obsolete now the Navy was prepared to provide flotillas for coastal defence, and should be replaced by submarines which "with even their present capabilities will afford an equally efficient defence,

[67] Kerr minute 6 January 1904, Adm 1/7717

[68] Fisher, *Naval Necessities* II p.449, Adm 116/3093

[69] Bacon report 31 May 1903, Adm 1/7725

[70] Selborne minute 4 March 1903, Adm 1/7717; see also Drury minute nd (late December 1903), ibid

and have a more deterrent effect against sustained attack, than would a submarine minefield." [71]

Arnold–Forster raised no objections to handing responsibility for inshore coast defence back to the RN [72]. The army estimates would have to be cut now the Boer War was over, and any savings were welcome. The Royal Engineers were largely unenthusiastic about 'aquatics', which kept engineers away from more useful work, and the regiment had only ever accepted responsibility for observation minefields with reluctance. (Mining, the Inspector General of Fortifications once observed sarcastically, "must not be treated as a trifling and distasteful branch of the all–important and attractive career offered by our navy." [73]) In addition, Arnold–Forster's service at the Admiralty had convinced him that the submarine was an important and devastating weapon. "The number of boats has greatly increased, and is increasing," he noted. "It seems to me therefore only reasonable that we should act in accordance with the expressed policy of the Admiralty, and take the first step towards divesting ourselves of a duty for the performance of which we get small thanks." [74]

The Admiralty authorised the removal of existing minefields early in 1904, and from February 1905 mine defences were formally abolished in British naval and commercial ports [75]. In their place, the Navy devised a scheme for coast defence based on the deployment of the limited number of existing submarine and torpedo boat flotillas.

Most submarines were immediately transferred to the command of the Home Port admirals at Portsmouth, Plymouth and Chatham. Boats of the Holland, A and B classes were used strictly for local defence, and only the Dover flotilla of C class boats, established in 1907, remained under the orders of the CinC Home Fleet, with instructions to deny the Straits to enemy warships [76]. Although the local defence flotillas were stationed at

[71] 'Report of a conference between Admiralty and War Office representatives to consider the future functions of submarine mines in war' December 1903, Adm 1/7717

[72] Arnold–Forster to Selborne 2 November 1903, Add.Mss. 50318 fols.184–5

[73] Clarke to Surveyor–General of Ordnance 23 November 1885, WO 33/46 p.9

[74] Arnold–Forster to Lyttleton 16 August 1904, Add.Mss. 50308 fol.13

[75] 'Mines in commercial ports' February 1905, Cab 4/1/49B

[76] 'Position of *Thames*' 3 November 1903, digest cut 11a, Adm 12/1389; 'Memorandum to Commanders–in–Chief, Channel Fleet and Home Ports, and Admiral (D)' 20 May 1905, Adm 116/900B; 'Local defence' nd (1907), digest cut 11a, Adm 12/1440

the major naval bases before 1914 – not least for ease of maintenance and efficiency of training – it was planned that in wartime they would be divided up among Britain's defended ports, which would each be protected by two submarines [77]. Co–ordination of the local defence flotillas was the responsibility of the Admiral of Patrols, whose post was created in 1911 to unify the command of destroyer, torpedo boat and submarine flotillas.

Underwater craft made a substantial contribution to the British coast defences. They could, as the Navy had promised, attack enemy craft some distance from port, and their invisibility and mobility made them all the more effective. They were particularly invaluable on the east coast, whose defences were traditionally weak, and provided additional protection for the main naval ports from their bases at Sheerness and – in the immediate pre–war period – Dundee. Moreover the submarine, because of her small size, offered protection to a number of small harbours such as Great Yarmouth, which could not accommodate larger warships and which had hitherto been omitted from the list of British defended ports. "Taking the East Coast as a whole," concluded a War Staff evaluation, "the best form of protection against all kinds of attack may ultimately be found in strong submarine patrols, with the support of military forces and guns on shore." [78]

The Navy's new scheme of defence had severe defects, however. The east coast was more than 600 miles long and there were not nearly enough submarines to protect the whole of it. The enemy could attack at almost any point, and as Callaghan, the CinC, observed after the 1913 manoeuvres, "submarines alone are not sufficient for the defence of ports unless maintained at all vulnerable points in much larger numbers than now." [79].

The problem identified by Callaghan was exacerbated by Fisher's appointment as First Sea Lord. Recognising that the Navy did not possess enough submarines and torpedo boats to take over immediate responsibility for all coast defences, Kerr had agreed with the War Office that the defence of British merchantile ports should remain in the hands of the

[77] CID paper 'Coast defences of the United Kingdom and the question of a coast watch' by the Chief of Staff (Jackson), 15 December 1913, appendix I p.16, Adm 1/8917

[78] War staff comments 29 September 1913, Adm 116/1214

[79] Callaghan paper 'Remarks on North Sea strategy' 28 August 1913, ibid

army until enough torpedo craft had been built to allow their safe transfer to naval control. Fisher's distrust of the military prompted him to demand the immediate removal of army minefields at all commercial harbours [80]. In the short term, this decision deprived some 36 British and 14 colonial ports of their naval defences; in the long term it created a sizeable problem for the already under–manned and under–equipped submarine branch. In an attempt to work up a comprehensive scheme of coastal defences, Bacon was reduced to the lame suggestion that 800 civilians from the Naval Volunteer reserve could be trained to man small coastal boats, which would be laid up in reserve at merchantile ports and commissioned on the declaration of war [81].

This was sheer fantasy. Bacon himself was a leading proponent of the view that only highly trained specialist ratings could handle submarines. Civilians had no part to play in the creation of an efficient submarine service, and the proposal was nothing more than a plain admission that Fisher's coast defence policy was an unrealistic one. In 1914, no commercial port possessed its own submarine boats.

The First Sea Lord's response to the shortage of submarines was to step up orders for coastal boats. Having purchased five Hollands, 13 A boats and 11 B class submarines, the RN built no fewer than 38 C class coastals between 1905 and 1910. But even these vessels did not meet the demand for local defence submarines, and as late as 1914 the Navy was forced to assign overseas boats essentially coastal duties to make good the deficiency. "I consider it the most serious thing at present affecting the British Empire!" Fisher wrote in typically extravagent style. "That sounds *big*, but it's true!... I have not disguised my opinion in season and out of season as to the essential, imperative, immediate, vital, pressing, urgent (I can't think of any more adjectives!) necessity for more submarines at once, at the very least 25 in addition to those now ordered and building, and

[80] Arnold–Forster memo 'Submarine mining – withdrawl of colonial garrisons' 22 November 1904, Add.Mss. 50318 fols.175–6; Ottley 'Memorandum containing Admiralty views on submarine mines at commercial ports' 6 February 1905, Adm 1/8879

[81] Selborne to Arnold–Forster 14 November 1903, Add.Mss. 50308 fols.9–10; Bacon 'Report on the suitability of Royal Engineer stations...' 13 December 1903, Adm 1/7717; Bacon notes to 'Memoranda relative to service in submarines' 6 November 1906, Adm 1/7880. In an earlier attempt to provide comprehensive coast defences, Fisher had proposed using naval militia to man improvised torpedo boats (Mackay op.cit. p.127), and the Admiralty had once suggested laying up small ironclads which could be commissioned for the local defence of ports (Stanley Sandler, *The emergence of the modern capital ship*, Newark 1979 p.173).

100 more as soon as practicable." [82]

In order to ensure the maximum possible number of boats were built, Fisher decided in 1905 to limit to limit the cost of each submarine to a maximum of £60,000 [83]. Fortunately for the Royal Navy, the new policy – which would have made it impossible to build Lees' £85,000 D class 'overseas' boats – remained in force for only a few months; even so, there can be little doubt that the First Sea Lord's preoccupation with coastal submarines led him to abandon his previous interest in the offensive potential of underwater craft. With his tremendous energies chanelled into dealing with more urgent problems, Fisher did little to promote submarine development during his term of office. Not until he had left the Admiralty did he begin to agitate for the construction of large submarines.

The shortage of local defence flotillas soon began to worry Britain's strategists. The CID concluded it would be unwise to assume an invasion fleet would be spotted before it landed. There was no guarantee that unusual troop movements would be noticed in advance, and an enemy would probably attempt to decoy the main British fleet well away from the landing area. The coastal submarines were slow, and without excellent intelligence would be unable to intercept an invasion or raiding force before it landed [84].

The naval authorities were thus forced to declare that

> "the patrol flotillas, both of submarines and destroyers, instead of being frittered away on useless cordon and patrolling duties, should be kept concentrated and ready for action at selected sally–ports along the coast, ready to proceed in force to any point where on sure information an enemy is attempting to land. There is to be nothing like routine or sentry–go patrolling, except at the mouths of harbours, and that from time to time good bold reconaissances 60, 70 and 80 miles out to seaward should be pushed from each sally–port by the whole of the boats available."

[82] 'Submarines – a letter to the Controller of the Navy' December 1903, FP 4941

[83] Fisher minute 10 August 1905 to Controller's report of 19 July 1905, Adm 138/360A section 10; Watts memo 'New designs of submarine boats' nd (July 1906), ibid section 22

[84] 'Attack on the Briitsh Isles from overseas' 15 April 1914, Cab 3/2/62A

It was

> "quite *impossible* with such a small force to maintain a regular patrol, or still less a line of observation... It is not possible with the forces available for the patrol flotillas to prevent the enemies' vessels from reaching the British coast. Their dispositions are intended to make it certain that they [the enemy] will be attacked in force with the least possible delay... absolute certainty is out of reach." [85]

The Admiralty therefore adopted the policy of holding submarines in reserve at strategic points along the coast. "There will be no question of patrols in the sense of a continual watch at sea," decided Keyes in 1911, and in 1912 submarines were ordered to stay within a day's sailing of their home port [86]. Strategically, this meant that the line of observation (the coast) was, uniquely, behind the line of resistance (naval torpedo flotillas). Militarily, it meant that during the First World War, the risk of German bombardments of east coast ports was tolerated in order to maintain a force constantly ready to strike at an invasion fleet.

The 1912 manoeuvres confirmed that submarines, though effective in coastal defence, could not always prevent a landing. Despite the heavy preponderence of 31 coastal submarines to five on the Blue (defending) side, Battenburg's Red Fleet successfully 'landed' a force of 12,000 men on the North Sea coast and made off before the Blue flotillas could reach the spot. Three Blue submarines that were present did not materially interfere with the landing. Although highly artificial – the Blue boats argued they had not realised a landing was in progress because Battenburg's battleships had only to haul down one flag and hoist another to become 'transports' putting troops ashore – the manoeuvres did convincingly suggest that while a full–scale invasion remained unlikely, hit–and–run raids on a large scale were feasible. Submarines were involved in only nine of the 78 actions (11.5%) reported during the manoeuvre period [87].

[85] 'Admiralty notes' 14 April 1913, Adm 116/3381; Admiralty to Admiral of Patrols and Commodore (S) 11 November 1914, KP 4/11

[86] Keyes memo 3 June 1911, KP 4/13; de Robeck orders 30 April 1912, ibid. See also Fisher paper 'Submarines' 20 April 1908, McKenna papers MCKN 3/4, Churchill College Cambridge

[87] May's 'Narrative of events' 31 July 1912, MAY 10; DSF I, 352–3

The results of the 1913 exercises were still more disturbing to the 'Blue Water' school. On this occasion it was decided to land real troops from real transports, and Admiral Jellicoe took command of the Red Fleet. Having completely out–manouevred Callaghan and the Blue forces, Jellicoe successfully landed 48,000 men at Blyth and Sunderland on the north–east coast. The Red submarines (18 strong) were considerably more successful than the 30 defending Blue craft. During the two major raids only two ships were confirmed as sunk by Blue boats (eight were claimed), while Callaghan's fleet lost several major units to Red submarine attack. The inability of coastal boats to attack in shallow and confined waters was thoroughly exposed during the manoeuvres [88].

Submarines performed respectably enough under the more realistic conditions prevailing in 1913; they were involved in just under half of the 163 actions. But the lesson of the 1912 and 1913 manoeuvres – and of two World Wars – was that the submarine was not 'the answer' to attempted invasions and raids that Fisher had claimed her to be. She was at best only a part of a complex scheme of defences, and a considerable force of boats would be needed to provide complete protection for the coast. "In attempting to be strong everywhere, the patrol flotillas were weak everywhere," Churchill informed the Prime Minister after the 1912 manoeuvres. "[They] should be kept in had at good strategic points, neither scattered nor exhausted... so as to supplement and support the movements of the fleet." [89]

The Navy's inability to guarantee it could prevent landings by substantial raiding parties meant the land defences of the British Isles could not be scaled down. There had always been considerable disagreement between the War Office and the Admiralty as to the likely strength of a raiding party, but from 1904 to 1914 the maximum strength of an enemy force was regularly put at 70,000 men – regardless of the changing strength of Britain's coastal submarine flotillas [90]. Nor did the 46 boats available for local defence in August 1914 reassure the public that landings could not be made unopposed. Forts and fortifications were strengthened during the war,

[88] 'Umpire–in–Chief's report' August 1913, MAY 10; Madden notes nd (August 1913), ibid

[89] Churchill to Asquith 17 October 1912, Adm 116/3381

[90] Moon op.cit. I, 81; Marder, DSF I pp.344–57

and significant numbers of men were stationed in the UK to beat off an invasion. In 1914, Jellicoe suggested 300,000 troops should be based along the coast. Enemy landings seemed a serious possibility as late as 1917, and a major study of the threat of invasion was commissioned in that year [91]. The submarine, in short, provided a little additional security but made practically no difference to the scale of Britain's other coastal defences. Because the army retained responsibility for artillery and boom defences, it could not even be claimed that the submarine finally removed the danger of confusion and uncertain co–operation between naval and military commands.

The design of British submarines themselves, on the other hand, was heavily influenced by the Admiralty's decision to develop them for coastal defence. In the pre–war period little importance was attached to the speed with which a boat could dive because most submarines would serve in home waters where the enemy would come to them. There were no plans for coastal flotillas to undertake protracted diving patrols, and none for lengthy cruises in hostile waters during which extended surface cruising would be necessary to recharge exhausted batteries; in some quarters the ability to dive quickly was even . thought dangerous, because it increased the chances of an accident. In 1913, therefore, the RN specified a diving time of three minutes for standard overseas and coastal designs, and six for the double–hulled types with greater positive buoyancy then entering service. Wartime experience proved this was dangerously slow. "One of the chief lessons of the war," recorded the DNC, d'Eyncourt, "is that a submarine must be able to dive very quickly and the times which were accepted... have to be considerably diminished." [92]

Submarines designed for coastal defence also mounted only a limited number of torpedo tubes. Tubes and spare torpedos were extremely heavy and consumed valuable space, and the Hollands were given a single 18" tube, the A class one or later two, the Bs and Cs two bow tubes and the D class one stern and two bow tubes. The difficulty of securing a hit in wartime conditions was not widely appreciated; in pre–war manoeuvres, as

[91] Jellicoe to Admiralty 14 November 1914, Adm 137/965 fols.168–9; 'Anti–invasion conference 1917', Adm 137/1939, 1957, 1971

[92] D'Eyncourt submission 19 November 1915, Adm 138/435 section 56; see also DNC department submission nd (early 1913), Adm 138/404A section 8

we have seen, British submarines generally 'fired' at extremely close range – close enough to make the discharge of salvos to ensure a hit unnecessary – and were presented with more targets in a day than they would see in a year of real warfare. Coastals claimed fifty per cent hits in pre–war exercises, and the Admiralty, allowing for exaggeration, estimated that one torpedo in four would strike under wartime conditions [93]. "Two loaded torpedo tubes should be sufficient for practical purposes offensively," wrote Bacon in 1903 [94].

In fact the restricted number of tubes mounted in wartime submarines seriously limited their chances of securing a hit. With only one or two bow torpedo tubes, commanders of the B, C, D and E class boats had to rely heavily on their own skill, and on the accuracy of their often unreliable torpedoes, to score a hit on the elusive enemy. Submarines designed during and after the war were given an altogether more realistic armament of four or six 18" bow tubes.

The expectation, derived from experience with coastal boats, that submarines would attack from very short range also prompted the Royal Navy to favour beam torpedo tubes, a concept pioneered by the Italian submarine service, for its overseas types. Both the D and E classes lacked the manouevrability to make successful short–range attacks with bow tubes, and on one occasion a D class boat actually collided with its target after delivering an attack. "One effect of the increased size," wrote SS Hall of the 180 foot E class submarine, "has been to depreciate the value of bow torpedo tubes on account of the great speed and great diameter of the turning circle of the boat, which increases the danger of firing from the bow at an enemy at close range; while the stern torpedo discharge, though not open to this objection, is tactically less easy to manage and possibly less accurate." [95]

Beam tubes were considered for the D class, and the original design for *E1* called for the complete omission of bow tubes. Though the submarine was redesigned, the first eight Es were provided with two broadside tubes

[93] 'Coast defences of the United Kingdom and the question of a coast watch' (Appendix 2, note by Henry Jackson) 7 May 1914, Cab 3/2/71A

[94] Bacon report on B class design 7 November 1903 fol.10, Adm 138/180B section 31

[95] 'New submarine boat designs 1910–1911' nd (?October 1910) Adm 138/299A section 7a. See also Hall report 12 May 1910, Adm 116/1122

and only a single bow discharge [96]. Beam tubes were expected to be of great tactical value to submarines (particularly those taking part in a fleet action), since they would allow a boat to to attack while proceeding parallel to enemy vessels steaming in line ahead. However, the addition of another variable – the submarine's forward motion – to the already complex equation for aiming torpedoes made hits unlikely, and the accuracy of torpedoes fired from beam tubes fell off sharply when a submarine was moving at speeds greater than three knots. British submariners heavily favoured their bow tubes during the Great War, and by 1916 Hall was forced to admit that beam tubes were a failure [97].

Finally, British coast defence boats had a low endurance. No provision was made for crews to live on board and it was unusual for A, B or C class submarines to undertake protracted cruises. Because it concentrated its attentions primarily on coastal designs, Fisher's Admiralty was slow to grasp the impact a seaworthy overseas submarine would have for its offensive strategy.

The fall and rise of the British blockade

Unless an enemy fleet could be persuaded to offer battle, the safest way to protect trade, prevent invasion, transport an army and secure British lines of supply was to keep enemy fleets bottled up in their own harbours. This achieved, the Royal Navy would be free to intercept the enemy's trade and thus deny him materials and foodstuffs vital to his war effort. Blockade was a slow, sometimes uncertain and often inefficient way of fighting a war, but it was the only strategy that enabled a naval power such as Great Britain to fight alone against a continental land power – and it had the advantage of costing less, in men and money, than the maintenance of an army.

The earliest British assessment of submarines included sobering evaluations of their ability to smash a close blockade. By May 1903, Bacon had concluded that it was almost impossible for a ship to remain within 25 miles of a harbour guarded by submarines. "The risks of allowing a large ship to approach such a port are so great," he stated, "that I unhesitatingly

[96] AN Harrison, *Development of HM Submarines from* Holland No.1 *(1900) to* Porpoise *(1930)*, sections 4.4–4.5, BR 3043 (1979), copy in National Maritime Museum

[97] Hall minute 5 December 1916, Adm 138/588A section 3

affirm that in war time it should never be allowed." [98] The Admiralty took Bacon's report seriously enough to arrange more realistic exercises. The Spithead trials of March 1904 [see section 7.2], primarily intended to test anti–submarine tactics, set units of the Home Fleet against submarines guarding the approaches to Portsmouth; Bacon noted that "no blockade was maintained, since no ships dared to remain in the offing during the daytime." [99] Fisher, who does not seem to have understood the implications for British offensive strategy, was delighted; submarines, he wrote, "succeeded in the recent manoeuvres in sinking millions sterling of battleships and cruizers and established such a 'Funk' as to keep the Home Fleet miles away from Portsmouth!" [100]

In August 1904 a fleet assembled at Milford Haven for manoeuvres specifically designed to assess the effectiveness of torpedo craft operating against a close blockade [101]. Five Holland submarines and a force of torpedo boats and destroyers – designated Red fleet – were detailed to protect the port from a force of battleships, screened by cruisers and destroyers, which were to impose a blockade. The results were, Bacon wrote, "in every way satisfactory." [102] His submarines put four destroyers out of action for the loss of two of their own number (one of them to a ship already technically disabled by enemy action) – a considerable improvement on the ratio of losses at Spithead. The major Blue warships spent most of the manoeuvre period at Queenstown, and although the largest ship lost by the attacking side was a cruiser, the submarine exerted a very considerable moral effect. "The existence of the submarines made the close blockade of Milford Haven more difficult," reported the Umpire–in–Chief, "and the fact of their presence inspired fear, as they were repeatedly being reported off Queenstown (which caused the battlefleet, on its return to that port, to steam in with its nets down), whereas they never left the precincts of Milford Haven." [103]

[98] Bacon report 31 May 1903, Adm 1/7725; Marder, ABSP p.368

[99] Bacon report 24 March 1904, Adm 1/7795

[100] Fisher paper 'Submarines – second postscript' April 1904, Balfour papers Add.Mss. 49710 fol.139

[101] 'Great Britain: torpedo craft manoeuvres 1904' NID no. 754, December 1904 p.5, Adm 231/43

[102] Bacon report on the Milford Haven manoeuvres, nd (1904), Adm 1/7795

[103] 'Great Britain: torpedo craft manoeuvres 1904' p.70

Admiral Robinson, a former captain of HMS *Vernon* appointed to command Red Fleet, concluded that "battleships and cruisers are not safe within the radius of action of hostile torpedo craft, even though protected by a larger force of destroyers than is possessed by the enemy." He drew attention to Bacon's innovative use of submarines by night, which caused the enemy many problems "as these vessels are on dark nights practically invisible, even when on the surface, and could attack and sink blockading vessels with very little risk of discovery... I do not think that a single submarine would have been seen by the Blue destroyers but for the rule compelling them to fire Very's lights and so disclosing their position", ending his report by emphasising "the impossibility of close blockade of a port in which submarines are available." [104]

Bacon too had seen nothing to alter his earlier conclusions. The TBDs' fear of the submarine would, he observed, have the effect of "totally altering the nature of what has hitherto been their close blockading tactics." Destroyers would be forced to maintain a more distant blockade, and this would mean either greatly increasing the number of TBDs employed, or leaving dangerous gaps in the blockade line. The ICS concluded his analysis by asserting, "I look on this result achieved by the submarine boats as a fatal blow to the maintenance of close blockades by torpedo craft or destroyers." [105]

The 1904 manoeuvres concluded a period marked by growing anxiety about the efficacy of a close blockade. The advent of steam made the blockaded fleet more dangerous, less dependent on weather conditions, and less predictable in its movements once out. In 1884, Captain WH Hall of the Foreign Intelligence Committee (the forerunner of the NID), wrote a paper which suggested that "torpedo boats constitute the greatest danger to a blockading squadron" [106]. A year later, Admiral Hornby's squadron successfully evaded a less–than–efficient blockade in the first modern fleet manoeuvres.

The 1888 exercises were also designed to test the potency of the British blockade. A fleet representing the French and commanded by Admiral Sir George Tryon was blockaded in Berehaven and Lough Swilly. A stream of

[104] Ibid pp.77–8

[105] Bacon report on the Milford Haven manoeuvres, nd (1904), Adm 1/7795

[106] Quoted in Alan Cowpe, 'The Royal Navy and the Whitehead torpedo', in Bryan Ranft (ed), *Technical change and British naval policy 1869–1945* (London 1977) p.28

ships, totalling five cruisers and a battleship, ran the blockade in three nights and proceeded to run amok on the west coast Britain, forcing the two divisions of the blockading fleet to abandon the operation, effect a junction, and attempt to hunt down the enemy raiding force. This in turn allowed the remainder of the 'French' fleet to leave its ports and unite at a pre–arranged rendezvous. Having evaded the British, this combined force descended on Liverpool, captured the city and wrecked the port of Holyhead.

The blockade failed, noted the subsequent 'Report of the three Admirals', because too many of the blockaders were absent coaling at any given time, because the blockaded fleet had superior (overland) communications, and because "the constant torment of torpedo boat attacks" weakened the blockaders' resolve. The report suggested that, to be effective, a blockading force would need a superiority of 5 vessels to 3 [107] – an almost unattainable standard. Although the close blockade remained the mainstay of British strategy, therefore, it was from the mid–1880s a less than wholly practical proposition. Sir Frederick Richards, the pragmatic Senior Naval Lord, confirmed in 1893 that a blockade would be "extremely difficult, if not impossible" to enforce [108].

The swift development of underwater warfare made inshore naval operations increasingly hazardous. By 1900 the Admiralty was describing the submarine as "a very serious danger" to the blockade. In the 1901 Greenwich war game, players controlling the British fleet in the Mediterranean withdrew their units from the blockade of Toulon every night, "saving themselves from the risk of the torpedo by steaming away – so much so that 4am the nearest British ship was 100 miles away from the port." It was admitted that had the French side been allowed submarines as well as torpedo boats, a daylight blockade would also have been impossible [109]. Two years later, another Mediterranean war game pitted the Royal Navy against a Franco–Russian alliance; again the results suggested that British officers recognised the dangers of submarine torpedo attacks on blockading squadrons. RN forces kept well off shore and the blockade was

[107] Marder, ABSP pp.107–09, 111

[108] Quoted in ibid p.111

[109] Admiralty to Treasury 25 October 1900, Adm 1/7515; 'Strategical war game at Greenwich January–May 1901' NID No.642, November 1901 pp.9, 14, Adm 231/35

far from watertight. "The British fleet were extremely nervous as to attack by submarines," commented the official report. "The fear of submarines and the presence of French cruisers prevented the British Admiral from seeing the French transports, and he did not know there were any at Bizerta." All major losses incurred by British forces in the 1903 Greenwich game were inflicted by torpedo attack, and the report noted that "much more was achieved by the torpedo than has commonly been the case in manoeuvres, and besides the material effect, the fear of the torpedo exercised a most important influence." [110]

The manoeuvres conducted by Britain's naval rivals were no less portentious. The French regularly exercised their submarines against vessels representing British blockading squadrons [see sections 2.1 and 5.3], forcing Kerr to conclude that underwater craft seemed to "have achieved considerable success and a blockade must in consequence be maintained at a greater distance from their ports than formerly, thus affording greater facilities for their ships to evade an enemy." [111] The Spithead and Milford Haven manouvres thus confirmed the worst suspicions of the RN. Clearly there should have been a reassessment (at the very least) of the British blockade strategy at this point. In fact there was none.

There were several reasons for this failure. The acknowledged unreliability of manoeuvres made it easy to ignore awkward results, at least in the short term. British preconceptions, particularly those concerning the submarine's short range and inadequacy at night, took some time to dissolve away. This problem was, of course, exacerbated both by the lack of a naval staff and by the *materiel* preoccupations of the submarine service. Equally significantly, the counter–measures that were introduced were myopic, dealing only with the existing threat rather than anticipating its future development. It was suggested that the blockading forces need only withdraw a short distance out to sea to put themselves outside the range of submarines and torpedo boats, a solution that took no account of the rapidly increasing radius of action of underwater craft. It took the dramatic performance of submarines in the 1910, 1911 and 1912 manoeuvres to change this attitude.

The emergence of Germany as Britain's most likely naval enemy helped

[110] 'Strategical war game at the Royal Naval College Greenwich' NID no.706, October 1903 p.14, Adm 231/38

[111] Kerr memo 20 January 1901, Adm 1/7515; ABSP pp.388–9

to reawaken interest in the strategy of close blockade. The North Sea coast of the German empire was a mere 150 miles long. There were only two naval bases on it, and the whole could be dominated by a fleet on deployed across the mouth of the Heligoland Bight, which seemed to form an ideal blockade line. The geometrical beauty of this arrangement, and the comparative weakness of the German navy in the early years of the century, were powerful incentives to the close blockaders, and help to explain Admiral Wilson's determined advocacy of the seizure of Heligoland (preferably) or the island of Borkum to act as a forward base for the fleet [112].

Finally, it may not be too much to suggest that there was an element of desperation in the tenacity with which Britain clung to the close blockade. It was not at all evident that a more distant patrol line would be as effective, and the Admiralty failed to evolve alternate strategies that could bring equal pressure to bear on its enemies. Everyone (including the Germans) expected the British to establish a close blockade immediately upon the outbreak of war – if only because there seemed to be no alternative. The close blockade remained in favour largely by default, its efficiency greatly exaggerated and its usefulness largely unquestioned.

To what extent, then, was the submarine responsible for the final abandonment of the close blockade? In the 1880s and early 1890s the torpedo boat menace had been promptly and efficiently dealt with by the development of quick–firing guns and the destroyer, forcing the TB to become a creature of the night, and leaving open the possibility of a close blockade by day. Other *materiel* developments were more difficult to counter than the torpedo boat; accurate, long–range coastal artillery pieces were produced, and mine warfare was a serious threat. But both were, it was thought, a danger only at short range. The heaviest artillery could not be relied on beyond 25,000–30,000 yards, and no blockader was likely to get as close inshore as that. The mine was a weapon of great but largely unrecognised potential, with particular value in the predominantly shallow waters of the North Sea. But international law forbade the sowing of minefields outside territorial waters, and the unrestricted mine warfare practised during the Russo–Japanese war suprised and shocked western opinion. The flexibility called for by British blockade policy largely

[112] Marder, DSF I, 371–2

precluded offensive mine warfare on the part of the Royal Navy, and inhibited careful consideration of the problem [113].

The submarine posed quite a different, seemingly insoluble condundrum. She had the range to engage blockading vessels. She could attack an enemy force steaming outside territorial waters perfectly legally, and could not be avoided in the way that minefields, once located, could be avoided. She could (or so it was thought) discriminate between targets, perhaps even to the extent of picking off the Admiral's flagship. Most worryingly of all, the usual techniques of countering a new weapon were inapplicable. Submarine could not fight submarine, except in the sense of exacting retribution by matching an atrocity with an atrocity. Surface vessels, on the other hand, were horribly exposed to torpedo boats at night and now to submarines by day. There would be no respite for a blockading fleet. It was the certainty of attack, together with the impossibility of defence, that finished the close blockade.

The blockade line was gradually, grudgingly forced further out to sea. Late in 1906, Beresford's 'War tactics for the Mediterranean fleet' drew attention to the fact that "the effective radius of submarines is increasing, and the introduction of the submersible by the French is rendering the possibility of these larger vessels being met further off... large armoured cruisers are not to approach within 50 miles of a base where submarines are known to be unless it is for a specific object, small cruisers and destroyers being used inside this distance." The Admiral predicted that "many traps will be laid to entice large cruisers into waters in which submarines are stationed," and observed that the modified British policy would "prevent a close watch being kept on places like Toulon by any but small, fast vessels." [114]

In July 1908, war orders issued to the Channel Fleet still attributed greater influence to enemy destroyers and torpedo boats than to submarines. A close blockade was to be maintained by day, but at dusk British forces would pull back until they were 170 miles from the enemy coast. This was calculated to be the maximum distance torpedo flotillas could travel if they

[113] Alan Cowpe, *Underwater weapons and the Royal Navy 1869–1918* (London University PhD 1980) pp.190–2, 200, 205–07

[114] Beresford memo 'War tactics for the Mediterranean fleet', October 1906, Adm 116/900B

left the blockaded ports at dusk and returned at dawn [115].

Two years later, however, estimates of the submarine's radius of action had to be revised. In August 1910, three C–boats were sent into the North Sea from Dundee to find a blockading force steaming 300 miles off the coast in an unknown position. Without the help of surface warships and without precise directions, the submarines located the blockaders and returned safely by night. On a second occasion, three more submarines located and 'torpedoed' a gunboat (representing the enemy battlefleet) which had been patrolling 270 miles out in the North Sea [116]. In the manoeuvres of 1911, the Dundee trials were repeated in more realistic conditions when six submarines acting on imprecise information located a division of eight battleships cruising in the Channel and got in five attacks on them [117]. The significance of these exercises for the policy of the close blockade was obvious; Fisher summed it up by stating unequivocally that "*a blockade, however loose, is absolutely impossible for surface vessels provided hostile submarines are present.*" [118]

The 1911 naval war plans called for two destroyer flotillas supported by three cruiser squadrons to institute a blockade of the German Bight [119], and it was not until November 1912 that the Admiralty – in the face of some opposition from those who thought the threat from underwater weapons exaggerated [120] – finally adopted the policy of an 'intermediate blockade' by surface ships, recognising that to do otherwise would be to expose British ships to serious and continual attrition. The change in policy was initiated by Sir George Callaghan, who as CinC of Red Fleet during the 1912 manoeuvres had been considerably impressed by the performance of the Blue submarines [121], and supported by Captain Arthur Vyvyan, the

[115] Marder, DSF I, 369–70

[116] Submarine committee report no.4, 12 August 1910, Adm 1/8128; Hall report 'Exercises carried out by submarines during the month of July 1910', 5 August 1910, ibid

[117] Submarine committee report no.13, nd (1911) cited in TH40 pp.16–17, Naval Library

[118] Fisher paper 'The oil engine and the submarine' nd (February 1914) p.4, FP 4293/9. See also 'Note concerning a past trial of submarines' nd (mid–1913), FP 4291

[119] 'Blockade of the North East coast of Germany: procedure' 30 December 1910, Adm 1/8132; Callaghan to Admiralty 31 August 1911, ibid

[120] Cf. Roskill, *Admiral of the Fleet Early Beatty, the last naval hero: an intimate biography* (London 1980) p.56

[121] Ballard memo 'Remarks on war orders for an observation force in the North Sea' ▶

assistant to the Chief of the War Staff, who urged that "any attempt to keep a close watch on German exits with our existing force of surface craft would spell disaster. The cordon could be broken anywhere, our vessels would be destroyed in detail, and our general strategy totally disorganised." [122]. The RN now proposed to stretch a line of destroyers and cruisers from the Norwegian coast to the Dutch island of Texel, with the battlefleet in suport but well to the rear.

In July 1914 intermediate blockade was also abandoned in favour of the 'distant blockade' actually maintained in the years 1914–1918. The exits to the North Sea were to be sealed by fleets stationed in the Channel and on the Scottish coast, where they were, in theory, concentrated well beyond the range of German torpedo craft. Even at this late date there were concessions to the old spirit of blockade. The plan called for large–scale sweeps of the North Sea to tempt the High Sea Fleet into a decisive battle – or at least convince it that it could not venture far from its bases without encountering the British battlefleet [123]. Sweeps also offered the Grand Fleet regular and realistic exercises, helping to maintain morale and battle readiness superior to that of the Imperial German Navy. The war showed that a well–screened fleet manoeuvring evasively and travelling at full speed made a very difficult target for submarine attack.

The distant blockade, which so surprised the Germans when it was put into operation, and which served the British well in World War I, was introduced for a variety of reasons. Primarily it was a response to belated recognition that an intermediate blockade would still leave RN forces vulnerable to 'whittling down' that might eventually result in the loss of command of the sea. But it also recognised that cruisers and destroyers could not guard every mile of water, and would be exposed to very considerable wear and tear in the North Sea. A determined German attack on an intermediate blockade line would have drawn in the Grand Fleet unsupported by a substantial proportion of its cruisers and torpedo flotillas, some of which would inevitably be stranded at the wrong end of the 300–mile line of observation. In addition, the distant blockade recognised

16 September 1912, Adm 116/866B; 'Naval manoeuvres 1912: general remarks by Commander in Chief, Home Fleet' 5 August 1912, Adm 1/8269; Marder, DSF I, 371

[122] Vyvyan paper 'Remarks on the 1913 manoeuvres' nd (September 1913), Adm 116/1169

[123] Marder, DSF I, 372–7

Britain's exceptionally favourable geographical position relative to Germany. With the Channel sealed by Franco–British forces and the northern exits of the North Sea guarded by a Grand Fleet based on the Scottish coast, the High Sea Fleet was almost as useless as it would have been closely blockaded in its own harbours.

The strategy of distant blockade neverthless required the maintenance of an observation force off the German coast. Submarines were to prove ideal for this role, but only in the last years of peace did the Admiralty come to the conclusion that its own boats were capable of instituting a form of blockade. "[It] is problematical," wrote Keyes, "but worth trying for." [124]

The British concept of an 'overseas' submarine can be traced to three sets of war plans prepared by the war staff in 1908, which stated that "in view of the staying power of the latest submarines... we recommend their employment off the mouth of the Elbe and the Jade." The boats were to patrol off the German river estuaries, being relieved every three days, preferably by boats sailing from a temporary base on Borkum; from there they could also act as a reserve in case of a German attack on the blockading fleet. The planners considered that "the possibilities of their successful employment are considerable, and, we are of the opinion, should not be forgone." [125]

The 1908 plans were ambitious. British submarine technology was not yet capable of producing boats of suitable range and endurance. The B and C Class submarines, which Keyes considered "quite capable of operating on the enemy's coast" [126], and which would have been detailed to watch the German littoral in the event of war, could certainly reach the patrol grounds – but they lacked endurance and their seakeeping was inadequate for winter cruises in hostile waters. During the Great War, operational experience with the C class showed that their navigational instruments were inefficient and their periscopes were of dangerously poor quality [127]. To a submarine, in wartime, such defects were a matter of life or death, and the Cs were really of use only in reasonably good weather. A critic of the

[124] Keyes pencil draft of report, nd (?1913), KP 4/17

[125] War Plans W.1 and W.3, 18 June 1908, Adm 116/1043B, esp.fols 744, 753

[126] Keyes memo 3 June 1911, KP 4/13

[127] Waistell to Chief of War Staff, 8 March 1917, Adm 137/2071 fol.265. See also Keyes to Chief of War Staff, 5 November 1914, Adm 137/2067 fol.681

1908 plans would have to conclude that a staging post such as Borkum would have been required if the Royal Navy relied only on B or C class submarines for close blockade work, and the capture and defence of an island close to the enemy coast would have entailed an unacceptable naval commitment – as later, more realistic war plans acknowledged.

The development of the D class made the British plans much more realistic. The new submarines had two reliable diesel engines, were 180 tons heavier, and had 10% more positive buoyancy and more efficient navigational equipment than their predecessors. They could operate unsupported several hundred miles from their base. In the 1910 manoeuvres, the newly–commissioned *D1* steamed (with an experimental diesel engine) from Portsmouth to Milford Haven, and from there to the 'Blue' bases on the Scottish coast, cruising without escort for 600 miles. Her crew lived on board for a month during the manoeuvre period, and she finished it with fuel enough to steam for another 400 miles. Two defending cruisers were attacked and 'sunk' during the cruise, and the submarine also performed a valuable scouting role [128]. By 1912 Rear Admiral Ballard, the Director of the Operations Division, could write that the D class "have amply proven their ability to undertake independent offensive operations and might be detailed forthwith to occupy positions as an advanced force on the German coast." [129] All that was needed was an acceleration of the building programme for large overseas submarines [130]. If enough boats could be made available, wrote Jellicoe, "they can undoubtedly carry out a blockade of an enemy's coast in the old sense of the word." [131]

Keyes estimated that a minimum of 48 overseas submarines, split into four flotillas of 12 boats each, would be needed to mount a blockade. The flotillas would be split into groups of three and at least one flotilla would be required on station at any given time. Jackson, the Chief of the War Staff, thought 36 submarines "might be sufficient", but even that

[128] Hall report 'Exercises carried out by submarines during the month of July 1910', 5 August 1910, and Miller minute of 31 August 1910, Adm 1/8128

[129] Ballard memo 'Remarks on war orders for an observation force in the North Sea', 16 September 1912, Adm 116/866B. See also accounts of *D4*'s performance in the 1912 manoeuvres, especially the 'Narrative of events by Umpire in Chief' 31 July 1912, entry for 16 July, May Papers MAY 10

[130] War Staff comments, 29 September 1913, Adm 116/1214

[131] Jellicoe report on 1913 manoeuvres, 6 August 1913, Adm 116/3381

number were not available in 1914 because Keyes's experimental programme had been funded at the expense of the procurement of overseas types [132]. No more than 19 D and E class boats were completed by the time war was declared; Hall's programme had called for a minimum of 30 to have been built by that time. In order to make up the deficiency in overseas hulls, an additional construction programme was therefore authorised early in 1914 [see section 8.1], Keyes conceding that "the necessity of developing, and developing rapidly, a really effective Oversea type of submarine" was "a matter of the first importance" [133].

Concentration on experimental submarines had one other serious consequence for the new British blockade strategy: British overseas boats were fitted with quite inadequate wireless telegraphy (W/T) sets, capable of broadcasting signals for only sixty miles. Although Bacon had experimented with W/T as early as 1903, and though junior submarine officers acting on their own initiative had installed radio equipment in a number of B class submarines in 1910 [134], only a handful of D and E class boats had been fitted with approved sets by 1914. An official programme for the development of submarine W/T apparatus was instituted as a result of the 1910 trials, with the aim of producing equipment capable of transmitting about 30 miles and receiving signals at a range of 60 miles, but procurement was slow – partly because no signals ratings were available for service in the submarine branch [see section 4.1]. Only nine sets were provided for in the 1912–13 estimates [135], and coastal submarines were left to obtain their intelligence from shore–based sources before sailing. German submarines, on the other hand, had long–range W/T sets suitable for boats of their considerable endurance.

In August 1914 the British W/T installation programme was so far behind that several D and E class submarines were sent into the Bight without the equipment [136]. There were two unwelcome consequences.

[132] Keyes 'Precis of submarine construction' nd (1913) KP 4/5; Keyes pencil draught of report nd (?1913) KP 4/17

[133] Keyes to Churchill nd (?late December 1913 or early January 1914), KP 4/11

[134] Keyes minute 15 March 1911 and Candy report 24 July 1910, Adm 116/1361

[135] Keyes memo 18 November 1912, Adm 1/8269; Keyes minute 15 March 1911, Adm 116/1361

[136] Keyes to Jellicoe 4 August 1914, KP 4/30

British boats had to be accompanied by surface vessels – destroyers – which could pick up visual signals and relay short–range W/T messages to the Admiralty [137]. These TBDs were placed in an exposed position, and their presence gave enemy scouts notice of British submarine incursions. It was the lack of good W/T sets, and the perceived need to tow submarines into action, not any failure to appreciate the benefits of operating submarines covertly and alone, that caused early patrols to be accompanied by a destroyer escort. More importantly, submarines were unable to fulfill a proper patrol function without a reliable means of communication. Had the High Sea Fleet come out in 1914, the British patrols could not have reported their presence to the Grand Fleet. A change of orders meant that Keyes had to take a destroyer and hunt up and down his patrol line until each submarine was located, persuaded to surface, and spoken to at close range – an obviously unsatisfactory procedure [138]. "When our submarines leave home they are lost to use," complained Fisher. "It is vitally necessary that our submarines should be able to receive signals by day and night... at a distance of 300 miles maximum, also to send that distance at night as soon as possible." [139] But British submarines only began to receive long–range W/T sets in August 1916 [140].

Despite this, the submarine had a profound effect on British naval strategy. No close blockade was instituted when war broke out; instead, a distant blockading force was based hundreds of miles from the German coast, while an observation blockade was maintained by overseas submarines. The waters in between – the bulk of the North Sea, in fact – became a naval nomansland in which surface units hardly dared to move for fear of submarines and mines. The supremacy of the underwater weapon helped put pay to the idea – cherished by the serving admirals of both sides – that the naval campaign should be decided by a decisive battle. The submarine, as the most fearsome of the underwater weapons, was largely responsible for the sterility of the war in the North Sea.

[137] Henderson to Hamilton 10 December 1911, Adm 1/8273

[138] Keyes to Chief of War Staff 17 December and 21 December 1914, both KP 4/32; printed in Halpern I, pp.59, 61

[139] Historical Section summary of papers: Fisher to Assistant Director of Torpedoes 20 April 1915, Adm 137/1071 fol.431; see also Admiralty to CinC Portsmouth 13 June 1915, Adm 138/514 section 8, National Maritime Museum

[140] Marder, DSF III, 238

The failure to predict commerce warfare

In the Atlantic, in the Channel and in the Mediterranean, the war at sea was far from sterile – and again the submarine could claim the dubious credit for this unexpected turn of events.

In 1914 Britain imported more than half her food by sea. Systematic plans for the protection of this commerce had been made since the early 1870s, though they were not necessarily realistic and certainly took no account of the submarine peril. As Professor Ranft observes, "the near–defeat of 1917 was not due to previous lack of thought or to the allocation of inadequate resources... but to the poor quality of the thought and the consequent misuse of the resources." [141]

Before 1914, the main threat to trade was expected to come from enemy cruisers, perhaps disposed along the sea lanes prior to a declaration of war. Recognising that even limited success might spark off food panics or drive marine insurance rates to unacceptable levels, both Russia and France specialised – particularly during the ascendancy of the *jeune ecole* – in the production of fast cruisers which on occasion caused considerable disquiet in Britain. (The 1894 *Rurik* scare is a case in point.)

Plans to deal with marauding cruisers were defective in several important respects. The Empire's trade routes were thought of as roads that could be guarded by patrolling craft stationed at the nodal points where two or more routes crossed, and the emphasis in all British planning was on 'offensive' measures – however doubtful, however wasteful – to the virtual exclusion of defensive tactics, however efficacious. Convoy was ruled out by the anticipated inability of unpractised merchant vessels to steam in formation as well as by the apparent impossibility of escorting more than a fraction of the Empire's trade. There was, in addition, a belief that any modern naval war would be settled by decisive battle long before a *guerre de course* could bring Britain to her knees. Thus reassured, some strategists regarded seaborne trade as no more than suitable bait with which to lure enemy ships to destruction at the hands of the Royal Navy [142].

[141] Bryan Ranft, 'The protection of British seaborne trade and the development of systematic planning for war, 1860–1905', in Ranft (ed), *Technical change and British naval policy 1869–1945* (London 1977) p.1

[142] 'Great Britain: Naval manoeuvres 1906', NID No.817, May 1907 pp.323–5, Adm 231/47; Ranft op.cit. pp.19–20

The likelihood of commerce war decreased when Germany became Britain's probable enemy. Geography was against the younger naval power and – as had been confidently predicted by the Admiralty – German commerce raiders were relatively ineffective in action. They sank a total of only 441,000 tons of British shipping between 1914 and 1918, the equivalent of a poor month's work by submarines during the 1917 'crisis of the naval war' [143].

The submarine was a new and unexpected enemy in the *guerre de course*. Experience was to show that she was an altogether more formidable foe than the fast cruiser, for surface raiders had to steer clear of ports and risk rapid retribution by attacking rich but well–protected sea lanes. Submarines had the priceless attributes of stealth and invisibility. They could disappear as soon as their work was done, lurk in the approaches to ports (where they were very hard to avoid), and could – in the absence of effective anti–submarine weapons – wreak havoc upon the best–protected shipping.

None of the great naval powers regarded their submarines as commerce raiders before 1914. Their failure to do so is easily understood. Firstly, old conceptions of the submarine's potential lingered on. It was difficult to imagine short–range, low–speed coastal submarines as commerce destroyers; they might dominate the North Sea, but (as Arnold–Forster had suggested as early as August 1901) British shipping could be re–routed to major west coast ports such as Bristol, Cardiff, Liverpool and Glasgow, where it would be out of reach [144]. Even if submarines did somehow break through the Channel defences, the RN expected their low speed and restricted field of vision when submerged would make them easy to avoid in the broad expanses of the Atlantic. It was commonly said that submarines were valuable weapons in seas, useless in oceans [145].

By assigning submarines duties in coastal waters or on a patrol line off the enemy's coast, the naval staffs of Europe pigeonholed underwater craft, and reconsideration of the submarine problem was given a low priority. Similarly, there was little attempt to re–evaluate the *guerre de course*,

[143] Marder, DSF V, 110–111

[144] Arnold–Forster to Selborne 8 August 1901, Add.Mss. 50294 fol.6

[145] Cf. assessment in Admiralty paper 'Naval position of New Zealand', April 1913, Adm 116/3381

which the RN was convinced could only be waged successfully by a power that had command of the sea. Less than three per cent of British shipping was lost during the Napoleonic Wars [146], and history suggested the most successful wars on commerce had been fought by the UK. This idea was reinforced by Mahan's writings. No second–rank power, the American strategist taught, had ever influenced the outcome of a war simply by attacking commerce; the strategy was useless unless, by stretching enemy resources, it made a favourable outcome to the decisive battle more likely [147].

More telling were the legal restraints on a *guerre de course*. Successive multi–national accords had codified war at sea, and it was widely accepted that attacks on the enemy's commerce would have to be carried out in accordance with international law. The Declaration of Paris (1856) had outlawed privateering at the insistence of Great Britain. Signatories accepted that merchant vessels should be stopped and searched only if they were suspected of carrying contrabrand of war. If contrabrand was found, the Declaration went on, provision should be made for the safety of the crew, and the capture conveyed to port by a prize crew. Neutral vessels were immune from capture whether or not they were carrying contrabrand. It was therefore expected that on the outbreak of war a weak naval power would simply lay up its merchant ships and rely on neutral carriers, or perhaps re–flag its merchant marine *en masse*.

Most strategists believed the Declaration of Paris made a successful war on British commerce impossible. An Admiralty report on the 1906 trade manoeuvres concluded that a *guerre de course* "could not be sustained beyond 2–3 weeks... Public confidence would be quickly re–established and the security of British Trade assured." [148] The 1908 war plans noted that "attacks on British commerce are the least serious of all the possible German operations of War" [149], and a year later AK Wilson (shortly to

[146] Bryan Ranft, *The naval defence of British seaborne trade, 1860–1905* (unpublished Oxford University D.Phil thesis, 1967) p.249

[147] Bernard Semmel, *Liberalism and naval strategy: ideology, interest and sea power during the the Pax Britannica* (Boston 1986) pp.84–5, 89–95; Geoffrey Till et al, *Maritime strategy and the nuclear age* (London 1982) pp.153–4; Ranft op.cit. pp.5–6; Marder, DSF I, 358–61

[148] 'Great Britain: Naval manoeuvres 1906' NID No.817, May 1907 p.323, Adm 231/47 p.323

[149] 'War plan W.1: War with Germany' 18 June 1908, Adm 116/1043B fol.753

become First Sea Lord) told the CID that "neither party could do vital injury to the other, but that there would be enormous trade losses on each side... He expressed the opinion that British trade losses would cease fairly soon – in a much shorter time than six months for instance..." Beresford believed "it is ridiculous to assert that the trade of the Country would be paralysed and that our food supplies would be stopped." [150] In 1913 the Assistant Director of the Operations Division, Herbert Richmond, expressed the opinion that an attack on British commerce would be temporarily destructive but that it was a nonsensical strategy for a power which hoped to win command of the sea. "It is to be doubted," he wrote, "that the Germans would make the mistake of the later French school and attempt to reduce us by these means." [151]

Born of an age in which international law had taken a hand in 'civilizing' warfare, none of these writers could conceive of a war in which the stakes were so high that almost any strategem would be contemplated – one so fiercely contested that war aims were virtually unlimited, and one in which the very existence of the belligerents as nation–states might be at stake. But submarine boats had to wage a *guerre de course* ruthlessly or not at all. It was doubtful that they could accurately identify suspicious craft or distinguish between belligerent and neutral ships through a periscope, yet they were at their most vulnerable on the surface. Were they to order a suspect vessel to stop and submit to a search, they ran the risk of being shelled, rammed or outrun by their prey. It was practically impossible to provide prize crews; the British tried it in 1915, but gave the idea up because "having 12 extra people in a D class submarine adds very greatly to the discomfort" – though it was possible at a pinch [152]. Abiding by international law was so chancy that on least two occasions serious consideration was given to the idea of allowing British boats to wage unrestricted submarine warfare [153].

To most authorities, though, the whole idea was "unthinkable"

[150] 'Evidence of Sir A. Wilson on the scope of naval war plans', 1909, FP 4261; Beresford in address to Imperial Industries Club, nd (?1909), ibid

[151] Richmond paper 'Re. Commander in Chief, Home Fleet's letter on North Sea strategy', nd (1913), Adm 116/1169

[152] *D7* report of proceedings 24 December 1915, Adm 137/2075 fol.12

[153] *G2* report of proceedings 18 August 1916, ibid fol.67; Donaldson (Capt (S) Tees) report 'Operations with submarines against the enemy's trade', 21 January 1917, Adm 137/1926 fols.485–7

(Battenburg's opinion, according to Jellicoe) and "inconceivable" (Jellicoe's own opinion) [154]. "Submarines have a very limited sphere of action," wrote the CinC in August 1914. "They can't hurt our overseas commerce, nor can they help theirs to get out." [155] The civilian strategist Julian Corbett was sure that submariners "would not incur the odium of sinking merchant ships out of hand" [156]. Nor was he alone in this opinion: "The civilized world would hold up its hands in horror," asserted Dr Pearce Higgins, the international lawyer who lectured at the Greenwich War Course [157]. In June 1913, Sir George Clarke (Lord Sydenham) wrote: "I cannot believe that submarines will sink unarmed ships and I do not see how they can easily convoy them into port. In more barbarous days unarmed ships were not summarily sunk, and modern societies would not stand such proceedings." [158] Keyes, the Commodore (S), thought the whole idea "impossible" [159].

There were in fact precendents to suggest that a ruthless war on commerce would be waged by enemy torpedo craft. In the 1880s some proponents of the *jeune ecole* warned that their torpedo boats would be used without regard for the niceties of international law. Admiral Aube declared they would "send to the bottom cargo, crew and passengers, not only without remorse, but proud of the achievement." [160] In 1903 Admiral Lanesson stated that "even submarines" might be employed to sink merchant vessels [161]. Illegally–sown offensive minefields were a commonplace of the Russo–Japanese war.

It should nevertheless be stressed that neither Germany nor France seriously considered a submarine *guerre de course* before 1914. It is true that the idea was suggested on several occasions – notably by

[154] Jellicoe to Fisher 5 December 1914, FP 854; Jellicoe marginalia to Fisher paper, November 1913, FP 4290/3

[155] Jellicoe to Churchill 30 August 1914, Add.Mss. 49012 fols.17–19

[156] Corbett to Fisher 30 November 1913, FP 752

[157] Quoted in Hall to Fisher 26 April 1914, FP 803

[158] Sydenham to Fisher 28 June 1913, FP 705

[159] Keyes, NM I, 53

[160] Quoted in Marder, ABSP p.40

[161] Ranft op.cit. p.31; see also Marder, ABSP pp.224–5; Cowpe op.cit. pp.194–6

Kapitanleutnant Rust (1904), Karl Galster and Vice Admiral von Schleinitz (both 1908), and Kapitanleutnant Blum (June 1914) [162] – and that the German diesel/electric boats were quite suited to the role. But, as we have seen, Imperial Naval strategy was designed to produce conditions in which the High Sea Fleet might successfully challenge the Royal Navy for command of the sea. Nor was there any real connection between the French *jeune ecole* school and the German submarine war on commerce. French strategists accepted from the outset that they had to seek victory by some means other than by fleet engagements. The Germans did so only after the failure of their attempts to reduce the Grand Fleet to something approaching parity with the HSF. German submarines were to have assisted in this process, and were therefore primarily intended to promote a fleet action. Unrestricted submarine warfare sprang from German desperation; it was introduced reluctantly and in the face of considerable opposition from the naval high command. Even though Germany (confronted by the Admiralty's illegal decision to arm British merchant vessels) had a good moral case for breaking the law itself, the idea was popular only among junior officers [163].

Only a few British thinkers recognised, before 1914, that an illegal strategy might be resorted to by a nation which would otherwise be reduced to naval impotence. Fisher, Hall and Percy Scott accurately predicted the use of submarines in commerce warfare, and succeeded in half–converting Sydenham, Selborne and Balfour to their point of view. In one well–known passage Fisher pointed out that:

> "the 'protection of commerce' difficulties become far more acute when the potentialities of submarines as commerce destroyers are considered... the question arises as to what a submarine can do against a merchant ship when she has found her... in fact it is impossible for the submarine to deal with commerce in the light and provisions of accepted international law... There is nothing else a submarine can do except sink her capture, and it must therefore be admitted that

[162] Eberhard Rossler, *The U–boat: the evolution and technical history of German submarines* (London 1975) pp.32–3; Gary Weir, 'Tirpitz, technology and building U–boats, 1897–1916', *International History Review*, May 1984, p.181; Carl–Axel Gemzell, *Organization, conflict, innovation: a study of German naval strategic planning, 1888–1940* (Lund 1973) pp.62, 97, 140

[163] Till et al, op.cit. p.170; Holger Herwig, *The German naval officer corps: a social history, 1890–1918* (London 1983) p.186

> (provided it is done and however inhuman and barbarous it may appear) this submarine menace is a truly terrible one for British commerce and Great Britain alike, for no means can be suggested of meeting it except by reprisals." [164]

The idea of using submarines in so blatantly illegal a manner might have been abhorrent to Fisher's contemporaries, but it came naturally to a man convinced that war should be 'ruthless, relentless, remorseless.' In 1916, the former Sea Lord wrote to his old adversary, Tirpitz, "*I don't blame you for the submarine business.* I'd have done the same myself." [165]

Balfour, the former Prime Minister and future First Lord, shared Fisher's pessimism. "The question that really troubles me," he wrote, "is not whether *our* submarines could render the enemy's position intolerable, but whether *their* submarines could not render *our* position intolerable." [166] Selborne too was convinced that the immunity of private property at sea would prove quite spurious once war broke out [167]. In general, though, Fisher's prediction came as something of a bombshell. In 1914 the then First Lord, Churchill, wrote: "There are a few points on which I am not convinced. Of these the greatest is the question of the use of submarines to sink merchant vessels. I do not believe that this would ever be done by a civilized power. If there was a nation vile enough to adopt systematically such methods, it would be justifiable, and indeed necessary, to employ the extreme resources of science against them: to spread pestilence, poison the water supply of great cities, and, if convenient, proceed by the assassination of individuals." [168]

For many, fierce reprisals seemed the only possible response. When unrestricted submarine warfare was introduced, the Admiralty received suggestions from five different sources "that German prisoners be carried on Merchantile Marine [vessels] as hostages to act as deterrent to S/M

[164] Fisher paper 'The oil engine and the submarine', February 1914 fols.9–10, FP 4293/9; see also Hall to Fisher 26 April 1914, FP 803

[165] Fisher to Tirpitz 29 March 1916, in Marder, FG III p.334

[166] Balfour to Fisher 6 May 1913, Balfour papers Add.Mss. 49712 fol.91; see also Balfour to Fisher 20 May 1913, FP 691

[167] Selborne to Fisher 18 March 1914, FP 800

[168] Churchill to Fisher 1 January 1914, FP 763

activity." [169] Perhaps fortunately, the Sea Lords never acted on this advice. Instead, they began to develop the long–neglected anti–submarine capability of the Royal Navy with considerable haste.

[169] 'German prisoners as hostages' 13 October 1915, digest cut 11a, Adm 12/1539A

Counter-measures

THE DEVELOPMENT OF ANTI-SUBMARINE WARFARE

Even before the Royal Navy had acquired its first submarines, Britain's naval authorities acknowledged that the weapon was more likely to be used against them than by them. The earliest boats were ordered to facilitate the development of anti-submarine tactics, and by 1912 at the latest the submarine was generally recognised as a serious threat. It was vital that counter-measures be found, for as HO Arnold-Forster remarked, "our moral objections to any particular weapon will not prevent a foreign power using it against us. Other forms of protection seem to me more reasonable, and more likely to prove effective." [1]

Yet Britain entered the Great War without effective anti-submarine weapons. Her enemies were, admittedly, equally helpless when confronted by the underwater weapon, but this was of little consequence. The Empire's dependence on seapower and on seaborne trade made it uniquely vulnerable to the submarine; the pre-war failure to develop anti-submarine weapons and tactics almost cost Britain the war.

It is conceivable that the crisis of 1917 could have been avoided - anti-submarine warfare (ASW) made rapid strides when the country was genuinely threatened, and although the problem could not be said to have been solved by 1918 it was clear that the battle against the U-boats was being won. Resources, money and talent both civilian and naval were flung at the problem in a way that only emphasised the lack of all three before 1914.

No fundamental breakthroughs in technology or tactics had still to be

[1] Arnold-Forster memo 13 March 1901, Adm 1/7515

made; no anti-submarine weapon developed during the war could not have been invented earlier, and the most effective AS tactic of all - convoy - was centuries old. Only the pressing immediacy of the threat was new. In the pre-war period, slow recognition of the submarine's potential, the lack of a central authority charged with the development of anti-submarine warfare, and the staggering difficulty of penetrating the underwater world of the submarine had induced what was practically a mental paralysis in many of those charged with tackling the problem; there were no useful precedents, and the task of developing effective methods of attack appeared so intractable that it was generally agreed that avoidance and flight were the only sure solutions. In 1914 they were suddenly no longer enough.

The problem

Anti-submarine warfare has two components: detection and destruction. Before the war many attempts were made to effect the destruction of submarine boats, several of them holding out fair promise of success, but the problem of detection remained unsolved. Gunfire, ramming, lasso nets, explosive creeps and sweeps and rudimentary depth charges were all useless if the target could not be located; even if by some good fortune a submarine was caught on the surface or her periscope was sighted, it was unlikely in the extreme that she would still be visible at the moment an attack was delivered. The boats' invisibility shielded them from attack as effectively as it concealed their own acts of aggression.

The first attempts to detect submarines took three forms. Most obviously, a strict look-out could be kept from surface ships by the 'Mark I eyeballs' of men trained to recognise periscopes and conning towers. If successful this method did at least hold out the promise that patrol craft, scouts and destroyers could force the submarine to remain submerged where her speed and vision were seriously impaired, and harass her until a body of larger ships had passed out of range. The disadvantages were twofold: rapid exhaustion of the watching crew, and a high proportion of time-consuming false alarms caused by everything from shadows and sticks to whales and sea-serpents [2]. A more promising method of surface

[2] See Dr Bernard Heuvelmans, *In the wake of the sea-serpents* (London 1968) pp.397-400 for the May 1917 experience of the A.M.C. HMS *Hilary*. She opened fire ▶

observation was provided by the indicator net, a simple mesh designed to wrap itself around a submarine and carry away from its moorings, allowing patrol vessels to attack the intruder by following the movement of buoys. Indicator nets were laid abundantly during the war, most notably in the Dover barrage.

The second method, echo–sounding and its related techniques, was not widely understood before 1914, although methods of underwater sound signalling were developed and active interest in underwater acoustics had existed since at least 1800 [3]. The third, observation from the air, was better regarded and numerous attempts were made to spot submerged submarines from balloons, airships and aeroplanes from the late 1890s – a use of one radical innovation to combat another that represents an intriguing triumph of imagination over naval conservatism. Early aircraft nevertheless laboured under the twin disadvantages of low endurance and designs that hindered the observer's downward field of vision. With the exception of airships they also lacked the abiliy to carry the sort of bombs needed to disable a submarine boat.

When – if – a submarine *was* detected, there were also three ways in which she could be actively attacked: collision (ramming), explosives either fired or dropped (guns, bombs, depth charges) and towed explosives (sweeps and trawls). Although apparently less likely to reap success, weapons of opportunity such as the gun or depth charge proved to be more effective than the sweeps that were favoured before 1914. This was because they narrowed the gap between detection and attempted destruction. Sweeps tended to be used after a sighting to hunt a whole area; they were operated 'blind' and it is unsurprising that they accounted for only two German boats in the war. The passive obstructions used – nets and particularly mines – were effective precisely because they depended less on surface operators and could (in theory) be left *in situ* for long periods. Actually the fierce currents and adverse weather conditions of the Channel and North Sea reduced their effectiveness, but they were nevertheless vital in the anti–submarine war.

The actual destruction of a submarine was not necessarily the main aim

◀ on what was reported to be a sea serpent after mistaking its head for a periscope. It is possible, but unlikely, that the creature was actually a large basking shark.

[3] See Willem Hackmann, *Seek & strike: sonar, anti–submarine warfare and the Royal Navy, 1914–1954* (London 1984) pp.7–10

of ASW. As well as preventing an attack by keeping the submarine under water and away from its main targets, the defending surface forces could score a victory simply by damaging the boat [4]. It was recognised that the submarine was highly vulnerable and anything other than minor leaks were very dangerous because seawater would either sink the craft by destroying her buoyancy or generate chlorine gas by coming into contact with battery acid.

Even so, the difficulties encountered in anti-submarine warfare were evidently great. The usual solution to new problems in naval warfare - setting like against like - was far from obviously viable. The torpedo boat had been met by the destroyer, and one aircraft could fight another, but submarine v. submarine warfare was a desperate business in which the hunter could quickly become hunted and both combatants laboured under equal disadvantages. To be safe, a submarine boat on AS patrol had to be submerged, where her field of vision was restricted to what could be seen through a periscope raised a few inches above the surface, sometimes only for seconds at a time. Her target was small, manoeuvrable and acutely aware of the tactics and possibilities of submarine attack, and restrictions on underwater speed and endurance often made it impossible for a would-be assailant to get into an attacking position. In wartime the British found that only 8.1% of the torpedoes fired by one boat at another found their target, although the moral effect of such patrols in terms of forcing greater vigilance and caution from the enemy was great [see section 8] [5].

It was the weaknesses of the submarine rather than the strengths of her attackers that counted in World War I. Underwater craft were far slower than most of their prey and vulnerable on the surface, particularly in poor light when a boat was more likely to be caught unawares. Manoeuvres indicated, and experience proved, that it was difficult for a boat to hit a fast-moving hunter with torpedoes - but she could hardly remain on the surface to fight. If enough patrol craft were available, if the conditions were favourable and the waters restricted or shallow, and the target's position approximately known, it was even possible to keep a sub down until her batteries were exhausted and the air so foul that she had to

[4] As was recognised in HMS *Vernon* annual report 1901, Adm 189/21 p.171

[5] HMS *Vernon* annual report 1918, Adm 189/38 p.152; Wemyss minute 12 September 1918, Adm 137/2077 fol.101

surface. But that was very rare. In general it proved far, far easier to neutralise a submarine than to destroy her.

The participants

The technical difficulties of ASW were great but they would not, perhaps, have proved insoluble if a determined effort had been made to confront them. None was.

The central problem was an administrative one. Not until December 1916 was there a full–time, properly funded department devoted to anti–submarine warfare. Before that, responsibility rested with a variety of individuals and groups, all of whom were also grappling with other problems. The gunnery school at HMS *Excellent*, which was the most important of the naval research stations, had no obvious interest in the submarine. HMS *Vernon* did some AS work but was officially responsible only for torpedoes, mining and diving. In addition, experimentation came a long way behind training in its list of priorities; most research was done by individuals in their very limited spare time. "From the 1900s onwards *Vernon*'s duties became simply too many and too varied for the existing organisations to cope," comments the historian of the torpedo service, Dr Cowpe [6].

The *Vernon*'s wartime captain, RS Phipps Hornby, complained that he was "regarded as an expert in detail of all that pertains to most forms of underwater warfare, and from personal experience I know the post is so burdened with paper work and detail that it is impossible for him to devote the time and attention so necessary to the broader aspects of his work." [7] In 1904 an addition was made to the staff when it was decided that ASW should become the joint responsibility of the *Vernon*'s captain and the ICS, but no anti–submarine experiments were made by the *Vernon* in the periods 1905–06 and 1908–1912 [8]. A high turnover of personnel,

[6] Alan Cowpe, *Underwater weapons and the Royal Navy 1869–1918* (London University PhD 1980) p.297. The whole section on the torpedo service (pp.276–97) is of great interest

[7] Phipps Hornby report 8 February 1916, Phipps Hornby papers, Phi 205 National Maritime Museum, quoted in ibid p.291

[8] 'Attack and defence of submarines' 15 October 1904, digest cut 11a, Adm 12/1402; HMS *Vernon* annual reports in Adm 189 series

under-financing and crowded facilities all contributed to the ship's inability to tackle the submarine problem effectively.

Most of these problems also retarded the submarine service's AS research. As we saw in sections 3 and 4, the issues of technology and supply preoccupied the pre-war Inspecting Captains and Commodores, and although always willing to co-operate with attempts to develop anti-submarine warfare they seem never to have initiated such projects themselves. The officers of the submarine service itself were however intimately involved in the pre-war development of ASW. Of all RN personnel they were naturally best acquainted with the problem, and were hard-headed enough to tread the middle ground between panegyric and ridicule: "It seemed to me of the greatest importance," Keyes recalled, "for the 'poacher to turn gamekeeper' and help the fleet to defeat enemy submarines. *We* knew our limitations and difficulties, but I found it as hard to make the converted enthusiast realize a submarine's limitations as to make an unconverted sceptic appreciate their powers." [9]

The active participation of serving submariners was the key to the successful development of AS tactics, for there was otherwise little continuity in the pre-war Navy's attempts to deal with the problem. Before 1904 AS work was theoretically the responsibility of the Captain (Destroyers), Home Fleet; from 1904 to 1911 it was, as we have seen, left to the ICS and the *Vernon*; and from 1911 the newly-created Admiral of Patrols also had a finger in the anti-submarine pie. None had much time to devote to the problem, and division of responsibility for ASW contrasts badly with the central control and absence of meddling which so contributed to the smooth and on the whole successful evolution of the submarine itself. Far from widening the scope of investigation, this division of labour effectively allowed the whole issue to be side-stepped for many years. Although all agreed - on a personal basis - of the vital necessity of improving the Navy's anti-submarine capability, each of the individuals concerned could argue, quite legitimately, that AS work interfered with the tasks with which they *had* been specially charged.

The appointment in May 1909 of a 'Committee on submarine experiments and anti-submarine experiments' [10] was therefore a definite

[9] Keyes NM I, 47

[10] 'Committee on submarine experiments' 11 May 1909, digest cut 11a, Adm 12/1464. The precise genesis of this committee is unclear. It probably came into being as a successor to Fisher's submarine committee of April 1909.

step in the right direction, and much useful work was done by this committee in the five years before the war. It was the first organisation specifically charged with developing AS techniques, taking over formal responsibility for ASW from the ICS. Even so the group was composed of part–time officers, numbering among its members Keyes and – as chairman – Cecil Burney, a squadron commander in the Home Fleet. More than 50 reports were made, but few were concerned directly with anti–submarine warfare because it was (quite properly) decided the capabilities of contemporary submarines had first to be ascertained, "and... many of the capabilities attributed to submarines need demonstration which can only be attained by systematic submarine exercises with the fleet." [11] These included the ability to find warships at some distance from port without the assistance of surface ships (confirmed by the Dundee trial of August 1910 – see section 5.1), the endurance of personnel and navigational efficiency. Many similar experiments had been made independently by the submarine service, albeit on a smaller scale, and their systematic repetition further reduced the time which the RN had to find and develop antidotes to the submarine peril. The five 'lost years' between the Spithead trials of 1904 [see below] and the creation of the Submarine Committee in 1909 could have made a significant difference to the RN's preparedness in 1914. One is tempted to draw a parallel with the development of Wright flying machine, which the US military were offered in January 1905 and which they did not accept into service until late in 1908. The European powers, too, delayed adopting the new weapon, often for the same reasons that the RN had continued to reject the submarine, and a Royal Flying Corps was not established until 1912. Given the tremendous strides made in aerial and anti–submarine warfare between 1914 and 1918, it is thus at least interesting to speculate on the consequences had military aircraft – and ASW – been developed vigorously from a somewhat earlier date [12].

With no central body to co–ordinate matters, individuals found it hard

[11] Report no.1 of submarine committee 20 April 1910, in 'Anti–submarine development and experiments prior to 1916', *The Technical History* (TH), vol. 40 (1920) p.9. Naval Library MOD.

[12] Cf. IB Holley, *Ideas and weapons: exploitation of the aerial weapon by the United States during World War I; a study in the relationship of technological advance, military doctrine, and the development of weapons* (Hamden, Conn. 1971) pp.26–8

to interest the naval authorities in their research. And although anti-submarine schemes were periodically sent to the Admiralty, naval officers were not unnaturally favoured when AS suggestions were considered. "Of the innumerable suggestions put forward, of which many of the more promising have been dealt with," said an HMS *Vernon* report of 1915, "few have proved of any value, while all of those now in use or contemplated have been suggested and in the most part developed by British Naval Officers." [13] The Admiralty does not seem to have recognised that its officers concerned themselves almost exclusively with attempts to improve primitive AS devices or adapt existing weapons developed for the surface fleet to attacking submarines. Nor did the *Vernon*'s attitude take account of the specialised skills required in anti-submarine warfare; it was one thing to skim through the untutored suggestions of civilians and another to resist the arrival of professional scientific help, as the RN did during the early days of the war [14].

Few schemes, whether military or civilian in origin, were actively investigated in the last decade of peace, and there was, of course, good reason for the theoretical bias to ASW before 1914 – namely the difficulty of arranging realistic practice. Manoeuvre rules had had to be changed to protect submarines, the relevant portion stating clearly: "During exercises no attempt of any sort is to be made to attack submarines beyond the theoretical reading of their secret numbers." [15] And as Lord Sydenham observed, "Much more could be learned in peace by scientific trials systematically carried out, but much will remain untried because the risks of trial are too great to be accepted. Only war can reveal the truth." [16]

To sceptics, the impossibility of organising realistic AS trials merely confirmed the submarine's weakness [17]. There was a general failure to recognise how few and far between real chances to sink underwater craft

[13] HMS *Vernon* annual report 1915, Adm 189/35 p.161

[14] Hackmann op.cit. pp.13–16

[15] M-branch 'Memorandum on submarines' nd (Oct 1910) p.11, RN Submarine Museum A1986/6. The secret numbers referred to were coded numerals painted on the side of conning towers and designed to be readable at certain ranges. Attacking vessels had to prove they had come into effective range by citing the secret number of the submarine they claimed to have sunk.

[16] Sydenham to Fisher 28 June 1913, FP 705

[17] Cf. EE Bradford, *The life of Sir Arthur Knyvet Wilson* (London 1928) pp.189–93

would be, particularly if submarines did not have to come to the surface forces that were hunting them, as they did in manoeuvres and, later, under the convoy system. Most dangerously, the promoters of early AS weapons often failed to appreciate just how accurately delivered an attack would have to be to damage a submarine. This, it transpired, was to prove the major stumbling-block to the development of anti-submarine warfare in the pre-war period.

Despite the RN's stated policy of acquiring submarines to develop AS tactics, concentration on the technological evolution of the weapon and, in the strategic sphere, on its use for coastal defence was thus at the expense of developing counter-measures. Official papers that did consider the use of submarines against Great Britain almost invariably did so in passages that were short, ill-considered and unhelpfully vague. "It has been suggested," noted Keyes in December 1914, "that the 'solution to the whole question lies in making the submarine strategically and tactically negligible'. This would seem almost as difficult a problem to solve as that of devising a means of destroying the submarine itself. The latter problem is very little nearer a solution than when the Anti-Submarine Committee was formed five years ago, although several distinguished Admirals, in collaboration with a number of younger officers, including almost the entire personnel of the submarine service, have very closely studied the question throughout this period." [18]

Anti-submarine warfare 1901-1904

After an initial flurry of interest caused by the decision to order submarines, attempts to develop anti-submarine devices were largely suspended until AK Wilson's December 1903 decision to hold fleet manoeuvres early the following year [19]; instead Bacon was permitted to spend six months working up the Holland craft and a further six practising them against their tender in secluded waters [20]. This was an entirely

[18] Keyes report 26 December 1914, KP 4/28

[19] TH 40 p.2

[20] Bacon report 'Remarks on the practices with submarine boats' 16 January 1904, Adm 1/7719

sensible policy, and it ensured that when submarines did come up against major surface units the results would be as reliable as the manoeuvres could make them.

The years 1901-1904 were a period of optimism; most of those involved seemed confident that the submarine could be beaten. HO Arnold-Forster, for example, was bullish: "There are no doubt a great many ways of rendering the attack from submarine boats innocuous. Nets and blockade mines besides other means can be, when necessary, devised, the fatal effect of which, in addition to the inherent difficulties of submarine navigation, are so great that I am not apprehensive of submarine boats ever becoming formidable." [21]

The manouevres held off Spithead from 8-18 March 1904 were the first devised to test the primitive AS devices created by Wilson and the men of the Home Fleet. Every day for ten days, surface units steamed from Portland to the Nab with orders to simulate a close blockade of the naval base at Portsmouth. Opposing them were the five Holland class boats and *A1*, which were severely tested by spending eight days out of the ten of the manouevre period at sea. The submarines performed creditably, but to the uncritical observer the Spithead evolutions seemed quite promising; large numbers of boats were, in theory, put out of action while attacks on surface ships allowed by the umpires were few and far between. Wilson's destroyers 'sank' 14 submarines for no loss, but 87.5% of their claims were allowed and not a single submarine attack on the Home Fleet TBDs was adjudged successful [22]. The restraining influence exercised by the boats was harder to judge; capital ships were employed with unusual caution, but this fact was not readily evident to the uninformed observer — and nor were the unreal conditions imposed on Bacon's submarines. "These manoeuvres are the most misleading manoeuvres ever devised by man!" snorted Fisher. "There were the destroyers calmly laying over the submarines (so utterly out of the question in actual war), fishing for them as if they were trying to catch whiting! The whole thing was ridiculous and misleading in the extreme." [23]

The Spithead manoeuvres mark the end of the first phase of ASW

[21] Arnold-Forster memo 28 January 1901, Adm 1/7515

[22] Bacon report 23 March 1904, Adm 1/7795

[23] Fisher, 'Submarines — a letter to the Controller of the Navy' 20 April 1904, FP 4941

development. By the time they were over, most of the anti-submarine tactics used in the Great War had at least been mooted. During the next decade these ideas were tried out and in some cases developed, but few if any original suggestions were made between 1904 and 1914.

Prevention - destroyer screens, aerial patrols, nets and mines

The simplest method of preventing submarine attack was to harass them with destroyers. Anti-submarine operations seemed a natural extension of the TBD's old function of dealing with enemy torpedo craft - but there were important differences. The gun and the torpedo were not ideal AS weapons, and against a supremely elusive enemy the destroyer's superior size and speed were not the advantages they might have been. It seemed that her role was to be limited to prevention: "Destroyers may worry submarines by feinting attacks and then retiring and so try to wear them out," noted Captains Bacon and Charlton in May 1904 [24]. The Controller, William May, agreed with this assessment: "There can be no doubt," he remarked, "that when submarines are harassed by a well-organised combination of small boats or vessels their attention must be taken off the primary object of the submarine, viz - the battleships." [25] A destroyer screen, constant high speed and zig-zagging by all units, deceptive fleet formations to take advantage of the submarine's difficulty in determining course and speed through a periscope, and preferably open order were suggested in an attempt to foil underwater attack. The value of such tactics was indicated by the manoeuvres of 1904 (which "established the value of destroyers as a guard to the fleet in waters suspected to be infested with submarines" [26]), 1912 and 1913 and confirmed by the test of war. It was rare indeed for a squadron to go anywhere without being accompanied by a

[24] 'Proposed operations' - enclosure 1 of Bacon and Charlton to Fisher 6 May 1904, Adm 144/27 fol.35

[25] Controller's minute 30 June to Bacon and Charlton report 6 June 1904, Adm 1/7719. See also the similar sentiments expressed by SS Hall in 'Memorandum on submarines' 8 April 1910, Adm 1/8119

[26] Wilson report 22 March 1904, Adm 1/7795

horde of chivvying mosquito craft [27], and the submarine failed to sink a single dreadnought in the four years of conflict. The fate of the pre-dreadnought battleship *Formidable*, sunk on New Year's Day 1915 by U24, only emphasised the dangers of sailing unescorted, moving slowly and steering a steady course.

Nevertheless, the TBD was at first thought of as little more than a decoy and a distraction. Trials showed that a scouting force had little chance of spotting a submarine before being seen itself, and it was averred that a single destroyer would find the underwater craft "a veritable danger" [28]. To the suggestion that patrols should be kept up off enemy bases to force submarines to dive as soon as they left port, SS Hall replied that nothing would please a submariner more: "Officers would be falling over each other to go out and attack... it is a matter for consideration how long the supply of watches could be kept up if the submarines were successful, as it appears to me at present they must be." [29] Destroyers needed a more potent weapon to become the hunters rather than the hunted; until one was produced, the scouts theselves had to be protected from the threat of attack.

From this point of view aircraft – either airships or aeroplanes – were of obvious value. And they offered other advantages too: speed of approach was much faster, perhaps 60 or 70 miles per hour rather than 25, so the chances of catching a submarine unawares were that much greater. Aircraft could scout large areas quickly and push ahead of the fleet with relative impunity; the Germans used airships with great success in this role. And the advantage of height sometimes made it possible to spot submarines proceeding under water.

The idea of using aircraft against submarines was a surprisingly old one. In 1899 the French flew a captive balloon in the Mediterranean and observed that although it was possible to spot submerged boats, "for every 1,000 feet elevation of the balloon the horizontal distance from the vertical at which the boat could be seen was 174 feet, a distance of no practical

[27] Cf De Robeck memo 6 August 1913, Adm 137/1926 fols.414–18; Callaghan to de Robeck, same date, copy in KP 4/14; Keyes, NM I, 51; Jellicoe to Fisher 5 December 1914, quoted in Marder, FG III, 87–8

[28] Bacon and Charlton report 6 June 1904, Adm 144/27 fol.58

[29] Hall minute to submarine committee report no.1 of 20 April 1910, quoted in TH 40 p.12

use except for watching the entrance to a narrow channel." [30] In 1905 the British made similar experiments with mines and noted, as had the French, that spotting was certainly possible to a depth of about 25 feet, so long as the target was not camouflaged. "As a method of defence against submarines it might be useful," considered a team from HMS *Indefatigable*, "but where a constant watch is required a balloon fails." [31] The problem of observer fatigue was a real one, and has already been noted in the case of naval look-outs; but equally important here was the clarity of the water. What was possible in the Mediterranean or the Adriatic (where in September 1916 Austrian seaplanes sank a French submarine that had been sighted proceeding submerged at a depth of 50' [32]) was not in the murky waters around Britain's coast. Conditions did vary – in July 1915 the *E18* found to her discomfort that a Zeppelin could still track her when she went to 70 feet, an experience that led to RN experiments with submarine camouflage – but in general British inshore waters were not happy hunting grounds for aircraft [33]. In 1918 the captain of HM Airship *NS 6* expressed the opinion that aircraft only saw a German boat "when he is caught napping or has been careless, and that he can watch us with his periscope up cruising at slow speed with little fear of detection from even the most experienced crews – it therefore requiring extreme vigilance during an entire patrol..." [34]. The camouflagers concluded that water clarity must have been exceptional in July 1915, and advised that repainting all RN submarines would be a waste of time.

If an aircraft did spot a submarine it would invariably be treated to the spectacle of a crash dive. It could however report the boat's position, relying on the craft's slow submerged speed to make it possible for surface units to avoid the danger zone, and it was in this role that flying machines

[30] 'Submarine torpedo boats – extracts from the reports of Captain Jackson RN and others', in HMS *Vernon* annual report 1899, Adm 189/19 pp.111-14

[31] Lt. Kiddle report 'Visibility of mines &c. from a balloon' 8 April 1905, Adm 1/7825

[32] See Alfred Price, *Aircraft versus submarines: the evolution of anti-submarine aircraft, 1912-1980* (London 1980) pp.3-4

[33] Waistell report 17 July 1915, Adm 137/2068 fol.426; Waistell to Hall 25 July 1915, ibid fol.429; Hall report 30 August 1916, Adm 137/2077 fol.56. Camouflage experiments are reported in papers dated between July and August 1915, Adm 137/1115 fols. 427-71. The French camouflaged their boats dark green in 1905 – see 'France: fleet, dockyards &c.' in 'Reports on foreign naval affairs' NID No.777, January 1906 p.21, Adm 231/44

[34] Woodcock report 'Submarine observations from airships' 5 April 1918, Adm 1/8521/109

were most successful during the Great War [35]. If it was lucky an aircraft might be able to attack, either by strafing with machine guns or by dropping bombs and later depth charges. The submarine was after all uniquely vulnerable to small-arms fire; a few bullet holes could make diving impossible. Perhaps the most notorious proof of this was the case of the British submarine *C25*, attacked by five German seaplanes in July 1918 and towed into port a bloody shambles, with five men dead and many more wounded [36].

Submarines certainly found aircraft disconcerting and an irritation, but for most of the war they were not that much of a threat. Aeroplanes that did catch boats on the surface usually found the puny bomblets which could be carried were not sufficient to finish them off. Airships had a better bomb load and good endurance but moved too slowly, so unless a submarine surfaced under them or could be tracked through the water they too had little prospect of success. The accuracy of all aerial bombing before 1918 was poor at best, and unless a direct hit was scored there was little chance of breaching an 11-16mm thick pressure hull, although it sometimes happened that a near miss jammed hydroplanes or disabled gauges [37].

Several British submariners nevertheless took an active interest in the development of aircraft and airborne ASW. Hugh Williamson, a B-class submarine captain who later transferred to the RNAS, wrote a paper on the subject in 1912, while in June 1914 Captain Hall went flying and reported on his return that he doubted whether contemporary aircraft were rugged enough for the job. It was an accurate enough assessment [38].

Back on the water attention was also turned to anti-submarine nets; indeed the first recorded AS proposal submitted to the Admiralty by a naval officer concerned this mode of warfare. Lieutenant Arthur Dawson's January 1901 plan was rejected on the grounds that a well-equipped submarine could undoubtedly burst through most wire mesh and that

[35] Keyes to de Robeck 21 August 1913, KP 4/14; Callaghan report 'Remarks on North Sea strategy' 28 August 1913, Adm 116/1214; de Robeck report 26 February 1916, Adm 116/1429

[36] Cobb report 7 July 1918 and subsequent correspondence, Adm 137/2074 fols.215-228

[37] Price op.cit. pp.15-16

[38] Williamson paper March 1912 quoted in ibid pp.7-9; 'Presence of hostile S/M' 8 April 1912, digest cut 11a, Adm 12/1500; TH 40 pp.33-4; Hall to Fisher 14 June 1914, FP 809

anchored nets would be extremely difficult to maintain in a tideway [39]. These same arguments prevailed into the Great War, when it was found that with much expenditure of effort it was possible to maintain gigantic barrages across the Straits of Dover and Otranto. But nets were of little use by themselves; it was usually possible for a submarine to pass over or under them if not through them, and constant patrols were therefore needed to monitor a barrier. It also transpired that unless they were liberally seeded with mines, nets were unlikely to entrap and destroy a submerged boat. 'Lasso nets' to be dropped in the path of a submarine were tried in 1904 but were soon discarded as unrealistic.

The advantage of netting was that it was a quick and convenient form of defence. The increased potential of underwater warfare caused a revival of interest in torpedo nets, and although they had been virtually ignored since 1890 those fitted to ships were once again regularly run out and the crews exercised in their use after 1905 [40]. They could be deployed in a few minutes. In an emergency it was expected that netting could be run up on board ship and readily laid, and the war caused immediate demands to made for huge quantities of indicator nets. In December 1914 an initial order for 60 miles' worth was made by the Admiralty, and these nets were the first of many tens of thousands delivered in the next four years [41]. But at the outbreak of war protection that available for individual ships had not been provided for fleets.

The problem of tideways, together with a failure to appreciate that German submarines could cross the North Sea and operate off the Scottish coast [see section 4.1], meant that only the five great naval bases had boom defences and no British port had nets of any kind in August 1914. "I *long* for a submarine defence at Scapa," wrote Jellicoe in the first few days of war, "it would give such a feeling of confidence. I can't sleep half so well when inside as when outside merely because I feel we are risking such a mass of valuable ships in a place where if a submarine *did* get in, she practically has the whole of the British dreadnought fleet at her mercy." [42] The Grand Fleet was soon forced by a series of scares to

[39] Wilson minute 13 June 1901 to Dawson plan 25 January 1901, Adm 1/7516; HMS *Vernon* annual report 1901, Adm 189/21 p.172

[40] Cowpe op.cit. pp.82–92

[41] HMS *Vernon* annual report 1902, Adm 189/22 p.85; Admiralty to CinC Home Fleet 27 December 1914, Adm 1/8409/15

[42] Jellicoe to Churchill 30 August 1914, Add.Mss. 49012 fols.17–19

retreat to Loch Ewe and then Lough Swilly on the north coast of Ireland – several hundred miles from the expected field of the Battle of Armageddon. But improvements in harbour defences were rapidly put in hand, with the result that by November 1918, 34 harbours were protected against underwater attack – a statistic that at once illustrates both the scale of the wartime submarine problem and the pre-war failure to appreciate its likely extent [43].

But it was the mine that proved to be the most potent AS weapon available in 1914. It caused practically half of British submarine losses [see appendix 8] and a rather smaller proportion of the German – an impressive statistic which becomes more so when it is remembered that mine warfare was badly neglected in the UK and that British mines were notoriously inefficient until copies of German models became available at the beginning of 1918. Combined with nets, mines made the task of forcing a passage through the Dover Straits or the Dardanelles much riskier; sown offshore or in the open sea they were unexpected and so even more deadly. Their use as 'blockade mines' had been suggested as early as 1901, but the independent use of the weapon in an AS role was otherwise entirely neglected until 1914 [44].

Yet the mine's success is easily explained. It was relatively cheap and could be laid in numbers. It required no supervision and could remain undetected and deadly for several months at least. It struck below the waterline and nearly always delivered a killer blow to the vulnerable pressure hull. It could lie in German home waters that could otherwise be blockaded only by risky patrols, and it was effective at any depth at which a submerged boat could operate. The most useful AS weapon was thus also the oldest, pre-dating the aircraft and the destroyer, the depth charge and the sweep [45].

[43] 'British naval effort 1914–1918' 24 December 1918, Adm 1/8547/336 fol.26. See also Prendergast & Gibson, *The German submarine war 1914–1918* (London 1931) pp.4, 14–16; Mackay, *Fisher of Kilverstone* (Oxford 1973) p.338; Marder DSF I, 406

[44] HMS *Vernon* annual report 1900, Adm 189/20 p.24

[45] See also SS Hall's assessment in untitled report of 30 August 1916, Adm 137/2077 fol.55

The failure of detection

Little can be written about attempts to evolve some form of submarine detection mechanism before the war, for the simple reason that little work was done. It was a task to which RN officers were peculiarly unsuited; acoustics, the subject in which the greatest strides were to be made, was not on the naval curriculum and can hardly have been foremost in the minds of men who had other professional duties to perform. The Admiralty nevertheless made no attempt to make good this deficiency by recruiting specialists from the scientific community, and naval officers appear to have subconsciously ignored the issue by concentrating on the apparently more immediate solution of developing weapons that could be deployed without a submarine being sighted, such as the sweep.

An induction balance whose equilibrium would be disturbed by passing boats was tested by HMS *Vernon* in 1882. It was designed by Captain McEvoy, who in 1893 also built the Navy's primitive first hydrophone. Various models were tested in the 1890s, and towards the end of the period directional microphones were also tried without conspicious success. After a series of trials had been conducted off Portsmouth, experiments were finally abandoned in 1903 for a familiar reason: it was not anticipated that the machines could be constantly manned without exhausting the operator, and attempts to build in a 'call up' system had failed [46]. Underwater sound signalling was more active, with rival British and American systems in use by the Royal Navy for ship-to-ship communication by 1909, but although one such system proved able to detect the noisier German submarines there is no evidence that this was realised before the war [47].

The hydrophone experiments seem to have owed much to McEvoy's personal enthusiasm, and they were carried out in an *ad hoc* manner. There was no guiding force to push forward development and, in 1903, no sense of urgency. Despite 1911 trials with an electromagnetic towed device developed by Vickers, therefore, detection of enemy submarines depended in 1914 on the sharp eyes of a look-out spotting a persicope feather or a

[46] Michael Wignall, *Scientists and the Admiralty: conflict and collaboration in anti-submarine warfare, 1914-1921* (London University Ph.D thesis 1987) pp.25-6; 'Detecting the presence of submarine boats' nd (1901), digest cut 11a, Adm 12/1365

[47] Hackmann op.cit. pp.9-10

boat that was slow to dive. In other words, it relied largely on the carelessness of the submarine captain who in all normal situations had every chance of not being seen. Only during the last stages of an assault was it necessary for him to raise the periscope within sight of surface warships, and throughout the war the majority of submarine attacks were detected only by the sight of a torpedo wake heading for the target. Although crow's-nest seamen were generally reliable - indeed over-cautious - and aircraft showed great promise, detection had failed. A submarine might be sighted when she invaded the surface environment, but in 1914 it was impossible to follow her back to her own world.

Cure - underwater explosions, gunfire and the ram

AK Wilson's outrigger torpedoes were the earliest explosive devices to be tested in the anti-submarine war. First developed in 1900, they were modified at HMS *Vernon* and used in the 1904 manoeuvres, but results were poor and the weapon was immediately discarded. The reason is instructive: according to Fisher it was unlikely that a destroyer could bring its outrigger within the 50 foot 'striking distance' necessary to sink a submarine, "so that it does not seem worth while to lumber up destroyers with this apparatus." [48]

The consideration of proximity dictated the future course of AS explosives development. Before the war two main types of underwater towed charges - the single and the modified sweep - were evolved from Captain Ottley's 1901 invention, the 'Otter' [49]. It is interesting to note that this early device was expected to do no more than disable its victim, for similar doubts were later expressed by those involved in the development of sweeps.

The single sweep consisted of a charge suspended at the end of a wire; a submarine coming into contact with the cable would in theory draw the explosive onto itself. The sweep could be towed at high speed and was usually regarded as an offensive weapon of some potential - "a formidable

[48] Fisher report 17 September 1903, Adm 138/180B section 26; 'Abolition of outrigger torpedo practice' 26 May 1904, digest cut 59-8, Adm 12/1405

[49] HMS *Vernon* annual report 1901, Adm 189/21 p.171

menace", the submarine committee termed it in July 1911 [50]. As the only offensive anti-submarine device available, the single sweep was popular in the 1913 manoeuvres, but even then its defects were recognised by the CinC, and in the Great War it proved of little service. Because it used only one wire, the area that could be searched by the sweep was small; success was unlikely without a recent clear view of the target, and by 1915 HMS *Vernon* had concluded that "such a sweep is now considered comparatively useless and incapable of further useful development." [51] A modified version with multiple wires and charges went some way to overcoming the problem, but tended to encumber and slow the vessel using it. The modified sweep was therefore reckoned more of a defensive weapon, and in this capacity was expected to be reasonably effective, if only as a deterrent – particularly if a number of vessels towed sweeps simultaneously. Keyes and his submariners thought it "not likely to prove of practical value in any other connection" [52]. But the modified sweep's great advantage was that alone among contemporary AS weapons it could be deployed without a target being sighted.

The great problem was still to get within effective range of a submarine whilst hunting 'blind'. In 1903, the French exploded torpedo warheads 30, 50 and 60 yards from a submerged submarine. On the last occasion there was a human crew on board; no harm came to them or to the boat [53]. 1907 trials at HMS *Vernon* resulted in the sinking of the obsolete *Holland No.5*, but indicated that a 100lb guncotton charge would have to be dropped "well within the submarine's length if any results are to be expected." [54]

Not until 1915 were the much larger charges needed to do serious damage tested. Trials showed that 250lbs of high explosive detonated within 50 yards of a boat would "at the *least* cause the submarine extensive damage and force her to open up, and this supposes that the crew are not

[50] Submarine committee report no.15, 17 July 1911, quoted in TH 40 pp.16–17

[51] Callaghan paper 'Remarks on North Sea strategy' 28 August 1913, Adm 116/1214; HMS *Vernon* annual report 1915, Adm 189/35 p.162

[52] Keyes to Chief of War Staff 16 October 1914, Adm 137/2067 fol.654; see also de Robeck memo 6 August 1913, Adm 137/1926 fols.414–18

[53] 'Naval progress and estimates 1903' (France), NID No.700, July 1903 p.25, Adm 231/38

[54] HMS *Vernon* annual report 1907, Adm 189/27 p.68; Wignall op.cit. pp.34–5

overcome by the explosion, which is more than probable." [55] This was an altogether more encouraging estimate, but it was made during the war and influenced only wartime AS development.

Only the latter calculation made the depth charge seem a reasonable proposition. Before the war there had been experiments with delayed-action lyddite shells, but development of this supremely simple weapon had not been pressed because it seemed unlikely that a surface ship could get close enough to a submarine for an attack to be successful; even the 300lb depth charge used in the later stages of the conflict had to be detonated within 14 feet of the target to be sure of a kill [56]. The depth charge could however be used in multiples and had the advantage that - unlike the sweep - it could be kept instantly ready for action.

Wartime experience proved what common sense had suggested: that simply damaging a submarine was often enough to thwart her. The war provided many graphic illustrations of the previously-untestable psychological effect of nearby explosions on a boat's crew. "The moral effect of a charge is very great, it is extremely upsetting," reported Lt Heaton of HM Submarine *H1* after one attack. VM Cooper of the *J2* was also badly shaken: "An experience of this nature is most trying as one can only wait and listen in silence and darkness without being able to strike back," he wrote. "In my own case, I felt at the time I would much rather remain on the surface and engage the enemy, however large and at all costs, than endure the strain of a further similar experience." [57]

Before 1914, however, the one certain way of making contact with a submarine was by ramming it. The idea became popular once the loss of the *A1* had demonstrated the vulnerability of a submerged boat in a collision, and in fact the *U15* - the first German submarine to be sunk in the Great War - went down after she was rammed by HMS *Birmingham* (August 1914). Jellicoe thought that there would be "many instances" in which ramming would be possible, and so it proved; but successful ramming was difficult if the intended victim could manoeuvre [58]. In the case of

[55] HMS *Vernon* annual report 1915, Adm 189/35 p.163.

[56] Wignall op.cit. pp.353-7

[57] Submarine committee report no.24 22 September 1911, quoted in TH 40 p.25; Heaton report 30 Spetember 1918, Adm 137/2075 fol.579; Cooper report 1 September 1917, ibid fol.141

[58] Jellicoe report 6 August 1913, Adm 116/3381; see Keyes memo 26 December 1914, ▶

the *U15*, for example, the British had the good fortune to come upon the submarine on the surface while most of the crew were below coping with an engine breakdown and an inadequate watch was being kept. In wartime, collisions were as often as not accidental, and the pre-war rules for manoeuvres recognised that.

Gunfire seemed more likely to bring success, particularly with the spread of quick-firing guns and improving naval marksmanship. But the submarine proved a most elusive target; all that could be hoped for was a few seconds' glimpse of a disappearing conning tower or periscope. It was no surprise that the latter target proved just too small - in 1910 no hits were registered from 1,600 Maxim rounds fired at a periscope from 1,000-1,200 yards [59] - but the naval authorities received a rude shock when in 1904 equally poor results were obtained with an immobile dummy conning tower 18 inches to three feet clear of the water. Only two of 271 rounds from destroyers' 6- and 12-pdr quick-firers found their mark from ranges of just 200-800 yards. The target was then enlarged to represent a submarine running awash but still only four of 79 rounds struck home. The weather during these exercises was fine and the destroyers steamed slowly to minimise roll; their shooting was described by the Controller as "poor by any standard" and by the First Lord as "scandalously bad" [60], but in reality it was little different from what might be expected of gunners firing in the press of action.

Capitulation

The 1904 and 1910 gunfire experiments were the only anti-submarine trials carried out before 1914 from which precisely quantifiable statistics could be drawn - another consequence of the *ad hoc*, part-time nature of the investigation. Certainly the failure to set up a properly-recognised body to co-ordinate ASW had numerous serious consequences. One was a distinct

◀ KP 4/28 for similar sentiments. This was, of course, also the conclusion of the nineteenth century proponents of the battleship ram.

[59] Submarine committee report no.8, 11 November 1910, quoted in TH 40 p.14

[60] May minute 30 June 1904 and Selborne minute 20 July 1904 to Bacon and Charlton report of 6 June 1904, Adm 1/7719

tendency to develop a limited range of existing ideas rather than search for new solutions. The destroyer screens, hand charges, towing charges, lasso and indicator nets used in 1904 were not much different from the AS devices suggested by Captains Ogilvy and Lees two years later; light indicator nets, the single sweep, high speed manoeuvres and advance screens were then under discussion [61]. In 1914 the Submarine Committee advocated a series of measures including aircraft, patrols and screens, sweeps, mine warfare and special formations of warships [62].

There was little sign of the AS weapons that were to prove decisive in two world wars. As late as 1915 HMS *Vernon* could make the remarkable statement that "it is the general opinion that all devices and methods of attack which have a reasonable chance of success are now in use or in process of development, and that it remains (December 1st, 1915) to develop accepted methods rather than to seek new ones..." [63] Sensible as this policy might have been in concentrating attention in the short term, it invited potential disaster in the long run and reflects the remarkable feeling of hopelessness that permeated the Royal Navy.

Study of specific anti–submarine weapons can give a distorted picture of naval AS activity. Despite the early breezy optimism of many officers, trials soon convinced most that the problem was an intractable one. Almost from the first it was admitted – expected – that there *was* no complete solution to the submarine problem. In 1903 Admiral Fisher had written that "the whole pith and marrow of the matter lies in the fact that the submarine boat... is up to the present date quite unattackable" [64]; in 1909 he reiterated the point, stating unequivocally that "no practical means at present exist or appear to be feasible for effecting the destruction of the latest type of submarine, or even of being warned of her approach." [65] In 1908 Hall badgered Fisher into appointing a committee to investigate anti–submarine warfare; it sat only once, in April 1909, and the ICS remembered "Sir John telling the committee that there would shortly be

[61] TH 40 pp.3–4; Lees and Ogilvy 'Report on the attack and defence of submarines' NID No.816, 30 April 1906, Adm 231/47 pp.1–11

[62] Submarine committee report no.54, 5 May 1914, KP 4/5

[63] HMS *Vernon* annual report 1915, Adm 189/35 p.161

[64] Fisher paper 'Invasion and submarines' December 1903, FP 4940

[65] Fisher paper 'The submarine question' nd 1909, FP 4238

large numbers of German submarines about and what were we to do about it etc etc. The committee said at present it seemed the only answer to submarine was submarine," and promptly disbanded. Nothing – apart from a few experiments with gun armament for submarines – resulted from the apointment of this committee [66]. Keyes was no less pessimistic: "The only real safeguard at present is avoidance, and the object to be aimed at is to locate the submarines before they can dive, fix the danger area, and avoid it," he admitted in 1912 [67]. And of a Submarine Committee report dated May 1914 the Commodore stated: "From the submarine officer's point of view, the main interest in this report lies in the statements it contains to the effect that... no effective means of direct attack on a submerged submarine has yet been produced..." [68]

In his 1913 paper 'The oil engine and the submarine', Fisher noted "that at the present time no means exist of preventing hostile submarines emerging from their own ports and cruising more or less at will." Furthermore, he believed, it was only "barely possible" that future developments would alter the situation [69]. When Lord Sydenham – who was not much of a believer in submarines – received an early draft of the paper he concurred with this opinion. "It must be admitted that this is rather a desperate business," he wrote; "no means can be suggested at present of meeting it [the submarine] except by reprisals." [70] Early in 1917, when the submarine peril was at its greatest, the Director of the Anti-Submarine Division admitted that "up to the present, no complete and practicable cure for the submarine menace has been, or is likely to be, discovered short of the destruction of the bases, which is obviously a military measure." [71] This near-capitulation helps to explain the Royal Navy's inability to come to terms with the submarine – a failure that resulted in intellectual near-paralysis which was to cost the country dear. Admiral Custance realised the danger: "The navy," he declared, "should not

[66] Hall to Keyes 15 December 1912, KP 4/22

[67] Keyes to de Robeck 3 October 1912, KP 4/18

[68] Keyes minute 10 May 1914 to Submarine committee report no.54, KP 4/5

[69] Fisher paper 'The oil engine and the submarine' December 1913, FP 4293 p.5

[70] Sydenham to Fisher 24 June 1913, FP 704

[71] 'Very secret: summary by DASD of anti-submarine measures', nd (c.February 1917), Adm 1/8480/36

be allowed to get into its head that nothing can be done against them"; it was a dangerously defeatist notion [72]. But he too had nothing specific to suggest.

The state of anti-submarine warfare in 1914

By August 1914, anti-submarine warfare was still imperfectly developed. The major offensive weapon was the single sweep carried by destroyers, which had to be detonated against a submarine's hull to be effective. There were no depth charges, and the British had no mines available for use against submarines. Nor were mines designed specially for use against underwater craft in production [73]. No method of detecting submarines underwater had been perfected, there were no submarine defences at any British port, and no nets other than torpedo nets were in service or reserve. RN submarine flotillas had developed no AS tactics and did not expect to be employed countering German U-boats. The vessels of the Grand Fleet relied for their protection on gunfire, torpedo nets, sharp look-outs, destroyer screens and their own improved underwater protection [74].

Just how unsatisfactory anti-submarine warfare was in 1914 is immediately apparent to anyone examining the wartime statistics for submarine losses. In four years of war, the Allies sank 159 German submarines (19 more were lost to other causes); mines and depth charges accounted for 74 (46%) of these. Only 43 U-boats (27%) were destroyed by anti-submarine weapons (gunfire, ram, nets and sweeps) in use in August 1914. The yearly total of submarines lost by the Germans climbed from the five sunk in the last quarter of 1914, through 19 and 22 in the years 1915 and 1916 respectively, to a more respectable 63 (1917). 69 U-boats went down in the period January-November 1918 [appendix 8].

[72] 'Notes by Sir Reginald Custance' August 1913, Adm 116/3381

[73] Mines designed for use against surface ships had horns only on their upper surfaces, whereas those intended for use against submarines had a number of additional triggers on their undersides.

[74] The history of underwater protection by sub-division is given in Cowpe, op.cit. pp.92-110.

The one redeeming factor in this sorry picture was that other navies were equally incapacitated by the submarine. If mines (which accounted for 70% of British submarines lost on active service) are excluded, no British boats were destroyed by underwater anti–submarine devices during the Great War. Even the Turks – who had the geographic advantages of the Dardanelles on their side – boasted a better record than the Germans with nets and gunfire [see appendix 7]. This failing was however but a small consolation to the United Kingdom.

The submarine gained hugely in importance by the inadequate development of ASW. Her virtues were maximised, her failings minimised. Her comparatively low speed and endurance mattered little; in 1914 the submarine could risk attacks and try manoeuvres that later became suicidial.

Because detection failed, destruction failed also. Because destruction failed, passive defence prevailed and avoidance seemed the best solution. The British inability to develop AS techniques before 1914 thus contributed materially to the direction taken by the war at sea.

Revelations

BRITISH SUBMARINES IN THE GREAT WAR, 1914–1918

At the moment Gavrilo Princip shot and fatally wounded Archduke Franz Ferdinand at Sarajevo, Winston Churchill was conducting a party of visitors around overseas submarines of the Eighth Flotilla based at Portsmouth [1]. As First Lord of the Admiralty, Churchill was in overall command of a volunteer force manning 72 boats. Flotillas of coastal submarines under the orders of the Admiral of Patrols were based at Portsmouth (11 boats), Plymouth (11 boats), and Chatham (24 boats) to guard the great naval bases. The Eighth Flotilla (17 boats), under the command of the CinC, Home Fleet, was to co–operate with the Grand Fleet and help to impose a blockade. Six B class submarines were stationed in the Mediterranean and there were still three C boats at Hong Kong [2].

By the time hostilities commenced on 4 August 1914, British and German submarines had already taken up positions dictated by war plans prepared in the last months of peace. Most of the 20 U–boats available to the Imperial Navy were assembled at Heligoland, where from 2 August they were escorted each morning to the patrol line from which they were to intercept the Grand Fleet as it made its expected rush into the Bight. They waited for a week, saw nothing and retired. A second patrol, by 10 U–boats sweeping 300 miles into the North Sea, met with similar lack of success, and two submarines failed to return to base [3].

[1] Cecil Talbot diary 28 June 1914, Imperial War Museum department of manuscripts 81/42/3

[2] Navy List July 1914; Duff paper 21 February 1912, Adm 116/1122

[3] William Jameson, *The most formidable thing: the story of the submarine from the earliest days to the end of World War I* (London 1965) pp.120–1

The British preferred to begin a distant blockade, sending two E class boats, *E6* and *E8*, to mount the first war patrol off the enemy coast and deploying the remainder of their submarines to protect the Expeditionary Force as it crossed the Channel. Keyes would have preferred not to station E boats off the enemy coast at all; because "their engines... [were]... still somewhat unreliable for long surface cruises", the two submarines were towed into the Bight by destroyers in an operation the Commodore described as "a hazardous experiment" [4]. But he was certain the Germans would come out – if not to offer battle to the Grand Fleet, then surely to dispute the passage of the BEF. "I cannot believe they will remain inactive when so much movement is in progress," he wrote [5]. Yet *E6* and *E8* saw nothing but enemy trawlers and a solitary U–boat. The High Sea Fleet remained stubbornly in port.

It took only one week of war, then, to confound the expectations of a generation of naval officers. There was to be no 'Battle of Armageddon'. The war would not be 'over by Christmas' – and submarines, as much as battleships, would decide whether Britain or Germany won command of the sea.

By 1914 the majority of British naval officers believed the submarine could be a relatively formidable weapon in certain circumstances [6]. The naval manoeuvres of 1912 and 1913 had demonstrated the dangers of trying to land troops on a coast defended by submarines, though it was easy to dismiss the limited successes of Keyes's flotillas as an aberration caused by loopholes in the rules of engagement [7]. It was obvious that the large overseas boats of the D and E classes could operate in open waters. But despite the efforts of AK Wilson and Keyes, the submarine branch had not been fully integrated into the fleet.

Most officers had encountered submarines only once or twice in their careers, and comparatively few were familiar with the overseas types that had begun to come into service. Keyes admitted that "the Commanding Officers of vessels generally, and of destroyers of the Home Fleet flotillas

[4] Keyes to Jellicoe 31 July 1914, Keyes papers KP 4/30, British Library; Michael Wilson, *Destination Dardanelles: the story of HMS* E7 (London 1988) pp.32–3

[5] Keyes to Jellicoe 2 August 1914, KP 4/30; see also Keyes to Sturdee 23 August 1914, ibid

[6] Cf. Keyes to de Robeck 10 August 1913, Adm 137/1926 fols.420–4

[7] Cf. de Robeck to Callaghan 20 August 1913, ibid fol.425

particularly – with some notable exceptions – appear to be very vague as to the capabilities of submarines, their methods of attack and of evading attack", and a full year before the outbreak of war was arguing "that the time has arrived to face this question if we are to prepare ourselves to deal with the submarine as an enemy." [8] But as late as December 1914 Vice Admiral Bradford, in command of the third battle squadron, could write to Jellicoe to request that "the policy of secrecy which has hitherto been maintained with regard to the details of construction, armament and capabilities of submarines be discontinued.

> "I have recently been directed by the Admiralty to furnish you with any suggestion I may have for attacking submarines actively, a subject that has been much in our thoughts for the last four months but the consideration of which is hampered on every side by the want of reliable information as to what a submarine can and cannot do... I submit that the provision of authoritative information on these points is of the first importance." [9]

The inexperience of ratings and junior officers in the Grand Fleet was exposed by the first major submarine scare of the war, which occured at Scapa Flow on 1 September. A 'periscope' was sighted as the fleet lay at anchor in the still–defenceless harbour, forcing Jellicoe to order all ships to raise steam. While they did so, torpedo nets were run out and small craft scurried about searching for the intruder, which was probably a seal. As a result of the 'First Battle of Scapa', the Grand Fleet put to sea for the first five days of September, then retreated to Loch Ewe on the west coast of Scotland for a further week for while defences for the Flow were improvised. A second scare, on 16 October, sent the British battlefleet to Lough Swilly, on the north coast of Ireland, for the best part of a month. For much of autumn, therefore, the Germans could have bombarded the east coast or played havoc with British lines of supply without fear of reprisal from the Grand Fleet [10].

[8] Keyes to de Robeck 10 August 1913, ibid fols.420–4

[9] Bradford to Jellicoe 11 December 1914, Ibid fols.511–12

[10] Jellicoe to Admiralty 14 November 1914, Adm 137/965 fol.166; Marder, DSF II, 66–9. After the Grand Fleet did return to Scapa, it was lucky to escape a genuine attack ▶

Even the senior officers of the fleet had little experience of submarines. Beatty, who as naval secretary to the First Lord had written a pre–war paper on the threat to surface ships from underwater weapons, reported sighting a periscope at the Battle of Dogger Bank, and was so convinced German submarines were present that he ordered his battle–cruisers to alter course, putting them astern of the fleeing Germans at a vital moment. (Marder notes "Beatty's action was the first of its kind in the war.") In fact no German submarine was within 60 miles of the battle; what Beatty had seen was probably a German torpedo surfacing at the end of its run [11]. Bayly, in command of a squadron of pre–Dreadnoughts, lost HMS *Formidable* off the Isle of Wight early on New Year's Day 1915 because he had failed to take adequate precautions against U–boats, even though his flagship had been attacked four times by submarines during the 1913 manoeuvres and the experience had taught him that "a battleship or battlefleet is incapable of defending itself from a determined destroyer attack, on a fairly dark night ...[or]... a submarine attack by day" [12].

Jellicoe, the British commander in chief, was one of the few senior officers with a real appreciation of the 'submarine peril' – although he, like many others, had under–estimated the danger before 1914. In 1909, as a gunnery specialist with no expert knowledge of underwater warfare, he wrote that "even if Germany spends a million a year on submarines, it will be eight years before the submarine menace in the North Sea is really bad, and I don't imagine we will wait eight years for war... It seems to be going rather too far to say that German submarine development must render the North Sea and all its ports uninhabitable by big ships... A time will come when the German submarines have been so reduced in numbers... that present conditions will be reproduced." [13]

Fisher had selected Jellicoe as a future CinC as early as 1910 as part of his drive "to push young men to the high commands who will think in submarines and 13.5 inch guns" [14]. Practically every letter he wrote to

◀ by *U18*, which penetrated the new defences on 23 November 1914 only to be rammed and sunk by a trawler.

[11] Stephen Roskill, *Admiral of the Fleet Earl Beatty, the last naval hero: an intimate biography* (London 1980) pp.54, 56; Marder, DSF II, 160–1; Jameson op.cit. p.147

[12] Marder, DSF II, 98–9; Bayly to Callaghan 28 July 1913, Adm 137/1926 fols.409–12

[13] Jellicoe to Fisher 18 April 1909, Fisher papers FP 382, Churchill College Cambridge

[14] Fisher to Balfour 23 October 1910, Balfour papers Add.Mss. 49712 fol.63, British Library; see also Ruddock Mackay, *Fisher of Kilverstone* (Oxford 1973) pp.425–6

the Admiral between 1911 and 1914 drove home the threat posed by underwater craft [15], and Fisher's protege was also one of the select group of officers to whom he sent a copy of the prophetic paper 'The oil engine and the submarine', which predicted attacks on British merchant shipping and warned of the damage 'submarine traps' could do to a battlefleet. Jellicoe was an early (1912) enthusiast for the fleet submarine concept, and his cautious handling of the Grand Fleet in waters within range of U–boats seems to have owed much to a study of Fisher's paper [16], but he remained guardedly optimistic that the menace could be defeated. "Unfortunately Germany has got a lead over us in overseas submarines and consequently the situation in this respect is not very easy," the CinC wrote to Churchill at the end of August 1914. "It is suicidal to forgo our advantageous position in the big ships by risking them in waters infested by submarines ...[but]... the submarine has a very limited Sphere of Action. They can't hurt our overseas commerce nor can they help theirs get out." [17]

Only the grim experience of war at sea, and in particular the German experiments with unrestricted submarine warfare in 1915 and from February 1917, convinced Jellicoe of the real threat posed by submarines. They were "the most serious menace with which the Empire has ever been faced," he wrote in October 1916, after U–boats had sunk 180,000 tons of British shipping in two months [18]. It took almost 2,700 British vessels, including 277 destroyers, 65 submarines and 2,054 motor launches, drifters and trawlers, to defeat the 111 U–boats in service when unrestricted submarine warfare was declared in 1917, the Admiral explained – figures that "show clearly the immense effect on Naval warfare, and Naval policy, of the introduction of a completely new offensive weapon." [19]

[15] Cf. Jellicoe papers, Add.Mss. 49006 (correspondence with Fisher), British Library

[16] Fisher to Jellicoe 30 December 1913, ibid fol. 27; Fisher to Jellicoe 12 + 30 November 1914, Add.Mss. 48990 fols. 165–72; Jellicoe to Admiralty 30 October 1914, Add.Mss. 49012 fols. 23–5; Mackay op.cit. pp. 445, 448–9, 451–3; Marder, DSF II, 75–6. On Jellicoe's interest in fleet submarines, see Keyes to Hall 19 October 1912, KP 4/22

[17] Jellicoe to Churchill 30 August 1914, Add.Mss. 49012 fols.17–19

[18] Jellicoe to Admiralty 29 October 1916, cited in Jellicoe, *The submarine peril* (London 1934) pp.1–5. See also Jellicoe's memo 'Naval policy in relation to merchant ship losses from submarines...' 21 February 1917, Adm 1/8471/241

[19] *The submarine peril* pp.183–4; Jameson op.cit. p.209. Jellicoe gives the number of U–boats in service at this time as 178.

The general failure of senior British naval officers to exploit the potential of their own submarines was no less obvious. Flotilla leaders commanding coastal boats complained of a lack of specific instructions from the Admiralty, which was quick to assume direct control over the deployment of overseas vessels [20]. There was no immediate attempt to move the maximum number of boats into the best offensive positions, and though a modest eight additional hulls were projected in the first wartime construction programme, Doveton Sturdee, the chief of the war staff, believed the score of overseas submarines available in September 1914 were "ample" for the war at sea [21]. He was wrong. The Royal Navy had 86 patrol craft in service on 11 November 1918.

Fisher's reappointment as First Sea Lord (30 October 1914) brought the Navy's most outspoken proponent of submarines back to the Admiralty. Within days a new Emergency War Programme had been drawn up, providing for the construction of extra vessels of every type. On 31 October Churchill asked Fisher "to obtain 20 submarines... in the shortest possible time" [22]; he responded by ordering 53, including 20 H boats from the Bethlehem Steel Company to be completed within ten months and no fewer than 31 of the proven E class submarines recommended by Hall. When a further 58 submarines were sanctioned in November, Hall and Fisher saw to it that none – with the exception of a handful of G class hulls – were built to the controversial designs pioneered by Commodore Keyes.

Keyes's termination of the Vickers monopoly did enable the Admiralty to order submarines from no fewer than 13 yards, and it was noteworthy that Scotts and Armstrongs completed their boats between 13 and 20 months more quickly than novice companies such as Palmers, Thornycroft and Cammell Laird. But every yard made exceptional efforts, and in 1918 the Director of Naval Construction observed that "the majority of the boats were completed in a time which, considering that the greater number of firms had no previous experience and were at the same time engaged in

[20] Cf. Vernon Haggard memoirs August 1913–July 1915, undated typescript in the RN Submarine Museum, A1985/42 fols.16–17. Haggard was in command of the depot ship HMS *Vulcan*, stationed with a flotilla of A boats at Dundee.

[21] Sturdee minute 12 September 1914, Adm 137/999 fol.191; Tudor paper 'Emergency war programme – new construction in destroyers and submarines for' 11 August 1914, Adm 1/8390/256

[22] Quoted in Mackay op.cit. p.464

other urgent work, compared extremely well with the building periods of other boats before the war." [23]

It took less than a month for submarines to prove they could have more than a 'moral effect' on the war at sea. On 3 September 1914, the British flotilla leader HMS *Pathfinder* was torpedoed and sunk (by *U21*) off St Abbs Head – the first warship to be sunk by submarine since the *Housatonic*. Worse was to follow. On 20 September, three elderly *Bacchante* class cruisers of what was only half–jokingly called the 'Live Bait Squadron' were surprised without an escort while patrolling off the Dutch coast. They had been on station for six weeks without sighting a submarine, and were taking none of the precautions suggested by the submarine branch after the Admiralty's pre–war A/S exercises. (In deference to experience, the *Bacchantes* had been detailed to operate with destroyers of the Harwich force, but these had returned to port during a spell of bad weather.) In the space of less than an hour their attacker, *U9* (650/837 tons), sank all three 12,000 ton ships and drowned nearly 1,400 sailors – "more men than lost by Lord Nelson in all his battles put together", as Fisher pointed out. Three weeks later the same submarine torpedoed and sank HMS *Hawke*, a somewhat more modern cruiser, off Aberdeen [24].

The loss of four cruisers in under four weeks had a great effect on British public opinion, and the Admiralty temporarily halted the movement of shipping in the Channel and placed restrictions on troop transports. But whatever its concern for the safety of naval auxiliaries, the RN was not yet convinced the submarine was a major threat to modern warships. The *Bacchantes* were obsolesecent and their loss did not affect the British war effort; moreover they had obviously been stationed in a highly exposed position and had been surprised while steaming at under 10 knots, while the *Hawke* had stopped to pick up mail. Reports of submarines at Scapa were infinitely more worrying, partly because they were infinitely less expected, but also because the Admiralty believed – correctly as it turned out – that warships in open waters, properly screened, and further from

[23] DNC Department report 'Warship construction during the 1914–1918 war' 31 December 1918, Adm 1/8547/340 pp.210–12, 225–6; 'Additional orders for submarine boats' 11 November 1914, Adm 1/8402/19; Fisher memo November 1914, FP 4305

[24] Fisher to Churchill 26 December 1914, FG III, 111–13; Jameson *op.cit.* pp.126–8

the main German bases, would still make difficult targets.

Nor should the significance of the Royal Navy's 'offensive culture' be under–estimated. British officers had been taught that losses were the inevitable price of aggression. From this point of view, the fact that the *Bacchantes* had not landed so much as a single hit on their attacker mattered less than the Admiralty's willingness to take the war to the Germans by stationing ships in hostile waters.

British submarines had few chances to emulate the U–boats. Max Horton, in command of *E9*, was able to avenge the *Pathfinder* by sinking the old German cruiser *Hela* on 13 September, but the major submarine operation of 1914 – the Battle of the Heligoland Bight, as it became known – was hardly a glorious success. Combining the Eighth Flotilla with two light cruisers and two flotillas of destroyers from the Harwich Force, Commodores Keyes and Tyrwhitt set off at the end of August to attack enemy patrols in the Bight. The job of dealing with the German scouts was given to Tyrwhitt's TBDs, while Keyes's eight E boats were stationed in three lines off the main enemy bases in order to attack the High Sea Fleet when it made its hoped–for sortie. Five British battle–cruisers supported the raid, which was so poorly co–ordinated that Keyes remained unaware of the assistance being lent by the Grand Fleet.

The British plan was for the outer line of submarines to make itself conspicuous in the hope of drawing enemy warships over the hidden inner cordon of E boats and into contact with Tyrwhitt's force. The scheme worked well, and on the morning of 28 August a German destroyer flotilla was sent out to hunt for an E boat that had attacked a patrol. The TBDs were soon spotted by Tyrwhitt, who gave chase in misty weather as the Germans fell back on Heligoland. Steaming at 25 knots, the Harwich Force blundered straight into the arms of a group of light cruisers from the High Sea Fleet. No sooner had Tyrwhitt disengaged than Keyes, in the destroyer *Lurcher*, came across a group of British light cruisers commanded by Commodore Goodenough, which were working in support of Beatty's battle–cruisers. Quite unaware that Goodenough was not berthed safely at Scapa, Keyes reported the newcomers as hostile, and Talbot in *E6* made a (fortunately abortive) attack on the Commodore's flagship, HMS *Southampton*.

Meanwhile the German CinC, von Ingenhol, had sent five more light cruisers into the Bight. These ships fell on Tyrwhitt's battered force and

were about to make short work of it when Beatty, steaming east at full speed, hurtled out of the mist with his five immense battle–cruisers and turned the tables on the German squadron. The cruiser *Mainz* was left ablaze from stem to stern, and *Koln* and *Ariadne* were both so badly damaged that they subsequently sank, the former with the loss of all but one of her men [25].

Beatty's intervention turned what could well have been a heavy British defeat into a triumph so rapturously received that its implications were never fully digested by the Admiralty. The original plan formulated by Tyrwhitt and Keyes called for light cruisers, destroyers and submarines from Harwich to go unsupported into the Bight, where it is clear that a number of British ships would have been lost. Keyes's submarines were unable to lend the Harwich Force useful support. They provided no intelligence of German movements to Tyrwhitt, and Keyes's own reports were of only limited use to Beatty. Nor was the overseas flotilla able to intercept German reinforcements as they left port.

The Battle of the Heligoland Bight did nothing to suggest that submarines were well suited to operations that called for close cooperation with the surface fleet. The British battle–cruiser force, which entered the Bight knowing that Keyes was unaware of its presence, suspected it was as likely to be attacked by British submarines as by German boats, and when *Lurcher* fell in with Beatty's squadron, Keyes was forced to go "ahead of them at full speed... to try and warn the submarines". In his report, the Commodore (S) admitted that "the unexpected appearance of the light cruisers and the battle cruiser squadron must have been most embarrassing to them [the submarines], as it was to me." [26]

German losses – in what had been thought were 'safe' waters south of Heligoland – nevertheless angered the Kaiser and forced von Ingenohl to restrict operations in the North Sea. "Submarines have entirely altered the conditions in our operational bases in the German Bight; in this confined area we are exposed to continual danger and continual observation, which he have no means of avoiding," wrote the German CinC [27].

[25] WS Chalmers, *The life and letters of David, Earl Beatty, Admiral of the Fleet* (London 1951) pp.141–55; Wilson op.cit. pp.45–54

[26] Keyes to Sturdee 29 August 1914, Halpern I, 11–14; Keyes to Christian (CinC, Southern Force) 29 August 1914, ibid pp.14–16; Keyes diary c.29 August 1914, KP 2/6

[27] Quoted in Jameson op.cit. p.126; see also WS Chalmers, *Max Horton and the Western Approaches* (London 1954) pp.9, 13–19

Unable to use the Bight, von Ingenohl withdrew the majority of his ships to the Baltic through the Kiel canal. By the end of 1914, therefore, submarines and mines had forced both major naval powers to virtually abandon the main body of the North Sea for substantial periods, creating precisely the 'naval nomansland' so widely predicted before the outbreak of war [see section 6.1].

The presence of German surface units in the east, where they could be used against Britain's ally Russia, caused Keyes to press for submarines to be sent into the Baltic [28]. Once there, he argued, they could be deployed against German supply lines, particularly the vital iron ore trade with Sweden. Although there was some concern that Danish neutrality might be compromised, the Admiralty detached three E boats to make the passage in October [29]. The operation was poorly planned and there was little co–ordination between the boats [30], but the two Es that completed the passage (which were later joined by a further three submarines of their own class and four C boats) scored numerous successes – without recourse to unrestricted submarine warfare [31]. After the Russian collapse Admiral Hoppman, one of the German commanders in the Baltic, told Captain FN Cromie, the Senior British Officer, that the E boats were "a constant anxiety to them, in fact the only one." [32]

Similar but superficially even more dramatic successes were scored in the Sea of Marmara, where a handful of Allied submarines succeeded in disrupting Turkish seaborne communications with Gallipoli between December 1914 and January 1916 [33]. By sinking two old battleships, several gunboats and numerous transports and dhows – and becoming the first enemy warships to penetrate the harbour at Constantinople in 500 years – E boats forced the Turks to send some of their supplies more

[28] Keyes diary 10 October 1914, KP 2/6

[29] The arguments were set out by Keyes in a letter to Jellicoe, 10 October 1914, KP 4/26

[30] Halahan notes late September 1915, Adm 137/1247 fol.29. Halahan was captain of *E18*.

[31] WF Nicholson minute 18 February 1916, ibid fol.138

[32] Quoted by Cromie in a letter to Hall, March 1918, cited by Michael Wilson, *Baltic assignment: British submariners in Russia 1914–1919* (London 1985) p.202

[33] Cf. Reports of proceedings, Marmara 1915, Adm 137/382

than 100 miles overland from the railhead to the front and prompted the Allied commander, General Hamilton, to describe each boat as "worth an army corps" [34]

The Baltic and Marmara campaigns were the most successful undertaken by RN boats in the Great War because they were the only ones that pitted British submarines against merchant shipping. Although the successes of the Marmara boats in particular have been exagerrated by British historians, the Trade proved it could operate with startling economy of force, and the speed with which the Swedish ore trade and Turkish military supply lines were disrupted by the torpedoes and guns of the Navy's overseas flotillas suggested that the their limited success in other theatres of war was due more to lack of opportunity than lack of skill. Certainly British submariners were no less skilful than their German counterparts [35].

The submarine branch emerged from the two campaigns with a tremendous reputation in British naval circles. Its officers had proved, beyond doubt, their bravery and competence. Its boats had performed unexpectedly well in making the difficult passages into the Baltic and through the heavily–guarded Dardanelles, the latter submerged and against a 4.5 knot current [36]. A handful of E boats had seen more action in a few days than whole squadrons of Dreadnoughts, swinging at anchor in the Jade river and at Scapa, saw in a year. They had also reassured the public that the Navy was "doing something" [37].

Even more significantly, British submarines had taken the war to the enemy in waters where no other warship could live, proving they were at their most deadly when deployed along an enemy's lines of communication and supply. No Admiralty war plan had predicted their use in such a role. RN boats had been expected to act as coast defence craft, as the

[34] Jameson op.cit. pp.164–9; Peter Shankland and Anthony Hunter, *Dardanelles patrol: the incredible story of the* E11 (London 1971)

[35] Beatty thought "Your submarine fellows are toppers... thank God their submarine officers are not in the same class as ours or we should have gone long ago." Beatty to Keyes 18 September 1914, KP 4/34

[36] Stoker report 9 January 1919, Adm 137/2077 fol.418. Stoker was captain of the Australian submarine *AE2*, lost in the Marmara in April 1915.

[37] One third of Britain's overseas submarines had been lost in action by August 1916 – a proportion "probably heavier than in any other of HM Forces," noted Hall. During the first three years of the war, annual losses ran at about 10 per cent per year of boats in commission. Hall report 30 August 1916, Adm 137/2077 fol.61; Hall report late August 1917, ibid fol.77

reconnäissance arm of the Grand Fleet, or in co–operation with British battle squadrons, because British naval strategy was largely one–dimensional.

The Admiralty gave little thought to developing independent tactics for the submarine branch, concentrating its efforts on integrating boats into a grand strategy for the battlefleet. Naval warfare was expected to revolve around the blockade, the decisive battle and coastal defence against the possibility of invasion. British command of the sea was, if not taken for granted, at least taken as a starting point from which to develop plans, and this seems to have blinded the Royal Navy to the likelihood it would have to send warships into waters dominated by enemy craft.

In the pre–war period coastal submarines had no sooner made a close blockade unthinkable than the overseas type made it possible again. In the Great War, confirmation that underwater warfare would severely restrict the role played by the surface fleet was immediately followed by the discovery that submarines could give the RN a presence in the most hostile of waters. The Admiralty – and particularly Keyes, as head of the submarine service – responded quickly to these unexpected circumstances, sending boats to the Baltic and the Dardanelles by the end of 1914. But at the same time the Navy failed to divert sufficient resources to let submarines make a decisive contribution to the war effort. There were never more than two boats operating at once in the Marmara, and it was their moral effect as much as their actual successes that forced the Turks to send supplies overland. During the crucial first winter of the war, when the Baltic was still relatively navigable, only *E1* and *E9* were available to help Russian naval forces protect their coast and strike at German shipping. More submarines might have had a decisive effect on the Gallipoli campaign and would certainly have hindered the Imperial Navy's attempts to use the Baltic as a training ground and turn it into a 'German ocean' on which trade could move freely and the High Sea Fleet operate without hindrance in support of armies on the Eastern Front.

War plans drawn up in the last years of peace made it clear that both overseas and coastal submarines were to operate strictly in support of the Grand Fleet. According to the 1914 plans, boats under the orders of the CinC Home Fleet were to be stationed "as far as their numbers admit in offensive operations on the German coast, on the lookout for outgoing or incoming ships... with the ultimate object of establishing and maintaining a

close watch on all the enemy's ports" [38]. As a result, the majority of Britain's overseas boats spent the war on monotonous but hazardous surface (and, later, diving) patrols in the Heligoland Bight, or held in reserve at Harwich in the hope that they could be used *en masse* to intercept the German battlefleet [39].

The continuing failure of the RN to provide powerful W/T sets for its submarines [see section 6.3] made it difficult for overseas boats to perform a useful scouting function in the first two years of war. D and E class submarines still relied on destroyers acting as signal relay vessels to pass on sighting reports. Since the range of most submarine W/T sets fitted in 1914 was no more than 20–60 miles, however, relay vessels were themselves forced into positions of considerable danger, and the majority of submarines therefore relied on traditional methods, such as carrier pigeons, to get their message through [40]. Results were unsatisfactory. One report, from an E boat near Terschelling, reached Harwich eleven and a half hours after it had been made – via a pigeon loft, the local post office and the Admiralty. This was reckoned to be good going [41].

Later in the war, however, long range W/T sets made a more subtle policy possible and patrolling boats were ordered to attack only if their targets were returning to port. If an overseas submarine spotted units of the High Sea Fleet heading into the North Sea, she was to surface in their wake and radio a position report, increasing the chances of a decisive surface action [42].

Where British boats were able to get in shots at major surface units, the results were generally disappointing. Between 1914 and 1918 torpedoes struck four German Dreadnoughts and the battlecruiser *Moltke* (the latter

[38] 'War plans – War with Germany 1914', Adm 116/3096

[39] See Hall memo 24 April 1917, Adm 137/627 fol.244 and 'Orders for Grand Fleet submarine patrols' 21 May 1917, ibid fol.439 for discussion of the respective merits of surface and diving patrols.

[40] Dumas (Assistant Director of Torpedoes) report on W/T sets 20 April 1915 in Historical Section summary of papers, Adm 137/1071 fol.431. In 1915 the RN laid down a specification for sets capable of transmitting a minumum of 300 miles; see Admiralty to CinC Plymouth 13 June 1915, Adm 138/514 section 8, Draft Room, National Maritime Museum. For carrier pigeons, see Callaghan report 31 October 1914, Adm 137/965 fol.115

[41] Jameson op.cit. pp.150–1. By 1916 signal intercepts decoded by the famous Room 40 were providing the Admiralty with detailed information of German movements.

[42] Hall report late August 1917, Adm 137/2077 fol.76; 'Special patrol orders for submarines of the 10th and 11th flotillas' 28 February 1918, Adm 137/871 fol.526

three times) without sinking any of them [43]. On the other hand, the attacks did have a tactical impact. In April 1915 Lieutentant Commander Laurence, in *E1*, sighted a powerful squadron operating in support of the German advance on Riga and hit the *Moltke* with a single torpedo, prompting Admiral Hipper to order the whole squadron back to Danzig. Laurence was subsequently decorated by the Tsar, who told him: "You have saved our town of Riga." [44] Fear of submarine attack also acted as a powerful disincentive for the Germans to brave the North Sea. For example, British boats intercepted the High Sea Fleet on each of the three occasions it left port in the 12 months following the battle of Jutland, torpedoing the battleships *Grosser Kurfurst*, *Kronprinz Wilhelm* (both hit by Laurence in *J1*) and *Westfalen*, plus the light cruiser *Munchen* [45]. As a result, the *Grosser Kurfurst* was unfit for service for three months, *Kronprinz Wilhelm* for one month and *Westfalen* for six weeks [46]. Enforced inaction, particularly in the months after Jutland, eventually had a disastrous effect on morale in the German fleet and contributed substantially to the outbreak of mutiny in 1918 [47].

Britain's coastal submarines had a generally less exciting war. The local defence flotillas were split up, in accordance with the war plans, to provide protection to a total of around a dozen ports. By November there were boats at Lamlash, Dover, Dundee, Harwich, Blyth and Sunderland and on the Thames, Forth, Tyne and Humber rivers [48]. The pre–war scheme – which had grouped all local flotillas under the control of the Admiral of Patrols – proved unwieldy, as Keyes had predicted it would, and from October 1914 boats were placed under the orders of the commanders–in–chief of home ports and the Admirals commanding the Dover Patrol and the Coast of Scotland. The Commodore (S) remained

[43] Hall report 15 January 1919, Adm 137/2077 fols.109–16

[44] WG Carr, *By guess and by God: the story of the British submarines in the war* (London nd [1930]) p.104

[45] Hall report late August 1917, Adm 137/2077 fol.76

[46] Siegfried Breyer, *Battleships and battlecruisers 1905–1970* (London 1973) pp.263, 276

[47] Marder, DSF V, 172–5, 333; Holger Herwig, *'Luxury Fleet': the Imperial German Navy 1888–1918* (London 1980) pp.138–9, 250–1

[48] Admiralty to Commodore (S) October 1914, Adm 137/1001 fol.221; 'Orders in case of invasion' 16 November 1914, Adm 137/965 fols.204, 206–13

responsible for administration and personnel [49].

Callaghan, in a memorandum on the possibility of invasion written late in October 1914, predicted the use of coastals in their traditional role as a second line of defence – backed by a third line formed by troops on shore – to free squadrons of the Grand Fleet for offensive operations. But he displayed new confidence in the ability of torpedo flotillas to halt an invasion without assistance. "We have no right to risk the Grand Fleet in operations where there are two other lines of defence," wrote the former CinC [50]. His successor seems to have concurred with this assessment. Coastal submarines, wrote Jellicoe, could be relied on to "free the Navy for its proper role – the destruction of the enemy's fleet – and will enable that concentration of force to be carried out which, in my opinion, is essential to secure the annihilation of the High Sea Fleet." [51]

The RN's confidence that its torpedo flotillas could prevent a full–scale landing led it to renew its blanket commitment to deal with any invasion fleet (August 1914) [52], but the Navy remained unconvinced that submarines could intercept a raiding force relying on speed and surprise to land troops or shell ports [53]. Coastal flotillas could not prevent the German attacks on Yarmouth (3 November 1914) and Scarborough, Whitley Bay and Hartlepool (16 December 1914), though the single C class submarine stationed at Hartlepool did play some part in driving off the German battlecruisers shelling the town [54]. By 1916, with the threat of invasion receding, C, F and V class submarines were widely used for training and practice work and their numbers were gradually reduced as more patrol boats came into service [55].

[49] Keyes to de Robeck, 30 July 1913, KP 4/13; Admiral of Patrols submission 13 October and Keyes minute 20 October 1914, Adm 137/1001 fol.216

[50] Callaghan memo 31 October 1914, Adm 137/965 fol.110. See also assessment by de Robeck, the Admiral of Patrols, in a letter to Callaghan 29 August 1913, Adm 137/1926 fols.437–8

[51] Jellicoe to Admiralty 14 November 1914, Adm 137/965 fol.171

[52] Marder, DSF II, 60–3. For a set of typical Admiralty orders to coastal submarines, see M–branch paper 'Action to be taken in the event of an attempted invasion', 25 January 1916, Adm 137/835 fols.44–5.

[53] Cf. Jellicoe to Admiralty 14 November 1914, Adm 137/465 fols.167–8; Beatty to Captains (S) Blyth and Tees 3 January 1917, Adm 137/1926 fols.93–4

[54] Marder, DSF II, 131, 141–2, 148; Jameson op.cit. p.143

[55] Hall report 30 August 1916, Adm 137/2077 fols. 53–4; Hall report late August 1917, ibid fol.74. By November 1918 there were only 20 coastals in service – 22 fewer than in ▶

The surviving coastal boats were increasingly drafted into service as anti–submarine vessels from 1915 – at first in conjunction with surface 'decoy' ships and later on diving patrols. This was a desperate measure on the part of the Admiralty, since British craft had been neither designed for nor trained in anti–submarine work [see section 7], carried no special anti–submarine weapons until the last months of 1918, when some J and K class boats were given depth charges, and depended on sharp eyesight and good luck to catch their prey. Keyes admitted in 1914 that "the odds against success are very large", particularly when the hunter was herself submerged [56] – and though 17 U boats fell victim to the torpedoes of their British counterparts during the war, Hall concluded in August 1918 that "the large part that luck plays during this most difficult work has been most strikingly shown." [57]

The biggest difficulty faced by British coastal submarines was not sighting enemy boats but manoeuvring into position for an attack. U–boats generally steamed at 10–12 knots on the surface, leaving the typical C class submarine, with her 8 knot submerged speed, at a considerable disadvantage. Late in 1917, therefore, Hall developed the specification for a boat designed for maximum underwater speed and firepower. The final design for what became known as the R class provided for a submarine with 6x18" bow torpedo tubes, capable of 15 knots submerged and 8 knots on the surface. The submarines were also fitted with five hydrophone cabinets to help them detect submerged enemy craft [58].

The R class boats – only ten of which were actually completed – were a technical triumph. They were surprisingly modern in appearance, and in post–war exercises regularly defeated the efforts of surface warships detailed to hunt them; furthermore, on the only occasion that one of the class actually encountered a U–boat she was able to manoeuvre into a perfect attacking position before being frustrated by a dud torpedo [59].

◀ August 1914. 66 more patrol submarines were in service at the armistice than when war was declared. Hall report 15 January 1919, ibid fol.113

[56] Keyes to Sturdee 11 September 1914, Adm 137/2067 fols.625–6. See also Fremantle minute 12 May 1918, Adm 137/505 fol.222

[57] Hall report 28 August 1918, Adm 137/2077 fol.103; see also Waistell report 8 June 1917, Adm 137/2071 fol.632

[58] AN Harrison, *Development of HM Submarines from* Holland No.1 *(1900) to* Porpoise *(1930)* (BR 3043, 1979) sections 10.9–10.14; 'Submarine administration', Technical History vol 21 p.16, Naval Library MOD

[59] Lockhart report of proceedings 11 October 1918, Adm 137/2077 fol.125

What was particularly significant about the class, however, was its development to fulfil a specific strategic need. Most pre–war submarines were multi–purpose craft and comparatively little thought was given to the best ways in which they could be employed. The R class – and to a lesser extent the sub–class of E boats converted into submarine minelayers [60] – were desgined to carry out very specific tasks. Only one earlier type had been developed in this way.

Fleet submarines

The idea of building a submarine swift and seaworthy enough to operate with the fleet had long fascinated the Admiralty. A flotilla or two of submarines deployed ahead of the line of battle could play havoc with a fleet deploying for action, offering all the advantages of surprise and seriously inhibiting an enemy admiral. Much more importantly, however, a submarine serving at sea alongside Dreadnoughts and battlecruisers could claim to be a real part of the fleet, and therefore of the Royal Navy itself.

The Admiralty's single–minded association of the Fleet with the Royal Navy, and of strategy with the Fleet, was the real force prompting development of the fleet submarine. There was an unspoken belief that no warship mattered if she could not serve on the high seas, and that all classes of warship would grow in size and power as they developed. The slow armourclad of the 1870s had become the Dreadnought. The frigate had evolved into the battlecruiser and the torpedo boat had been replaced by the destroyer. Now the Holland boat was to be succeeded by the K class submarine, belching steam and racing into battle at 24 knots to fulfil the long–standing and peculiarly British demand for seagoing torpedo vessels [see section 1.4]. "Without any doubt whatsoever," wrote Fisher, "a fast battle fleet which can always be accompanied by submarines under all circumstances would possess an overwhelming fighting advantage." [61]

Fleet submarines were expected to give the advantage to a navy deploying them before or during a decisive battle by striking at enemy

[60] Hall report 28 August 1916, ibid fol.204

[61] Fisher to Hall 4 September 1913, FP 726

capital ships. The Admiralty planned to use their speed to station them ahead of the British battlefleet but behind an outlying screen of cruisers. From this position fleet boats (ideally working in groups of three) would not only be able to dive on a signal from the scouts, thus giving them the chance to attack the enemy as he deployed for action, but would also be unlikely to hamper the movements of their own battleships [62]. A pre–war study conducted by the War College suggested that submarines working ahead of the fleet could operate successfully even when the enemy was aware of their presence [63].

Fleet submarines also promised useful support for detached British squadrons, which could retire over their positions if confronted by a superior enemy force [64]. Beatty's 1918 war orders for the Grand Fleet outlined a third scheme by suggesting: "It must be the main tactical endeavour of K class submarines to place themselves between the enemy and his base, and in certain cases, to attack the enemy on the reverse side from that on which our battlefleet will attack." [65].

There were two obstacles to the development of a technically efficient fleet submarine: speed and seaworthiness. The drive to substantially increase the displacement of British submarines began as early as 1904, when Bacon asked Vickers to draw up plans for a 1,000 ton boat with twin screws, oil engines and four times the battery power of the contemporary 190/205 ton A class. In 1911 Hall commented favourably on a design for another 1,000 ton boat which he thought would make "a most interesting comparison with a destroyer" [66], and by 1912 Vickers had started work on the 1,270 ton *Nautilus*, then by far the largest submarine in the world. In February of the same year, Keyes's submarine committee recommended the Navy should concentrate on the construction of two types of submarine: coastals and double–hulled, high–buoyancy overseas boats "for service on the enemy's

[62] 'Record of a conference held in the First Lord's room on 9th December [1913]', KP 4/10; Leir to Jellicoe 2 January 1917, Adm 137/1926 fols.631–33

[63] War College Tactical Investigation No.11, 27 April 1914, KP 4/14

[64] Keyes minute 18 August 1913, KP 4/11

[65] Grand Fleet Battle Orders 1 January 1918 in Bryan Ranft, *The Beatty Papers: selections from the private and official correspondence of Admiral of the Fleet Earl Beatty* (London 1989) pp.478–82

[66] Vickers to Bacon 16 May 1904, Vickers Papers VP 739 bundle 2, Cambridge University Library; Hall to Briggs (Third Sea Lord) 7 December 1911, KP 4/1

coast and for blockade work." [67] Early progress towards the production of a fleet submarine was so good that Rear Admiral Ballard, the DOD, thought "there is no great difficulty in the way of producing a sea–going submarine with a surface speed of 25 knots." [68] In 1918 Admiral Fisher – by now retired – even backed a design for a submersible battlecruiser of 30,000 tons, with 18" or 20" guns, capable of 30 knots [69].

But even the largest submarines were no use if they were slow, as the Navy discovered when boats were deployed with the fleet in peacetime exercises. In 1908, at around the time the War Staff was first planning to use submarines to blockade the enemy coast, Hall stationed three flotillas of coastal boats parallel to the friendly battlefleet, protecting it with "a minefield 30 miles long moving at 10 knots" at the cost of severely limiting its speed [70]. The development of efficient diesel engines made a considerable difference, and by 1911 Keyes was writing that "the D class can comfortably maintain a speed of 13–14 knots, and might well be employed in company with a battlefleet, particularly one expecting to fall in with a superior force." [71] The Commodore's theory was tested when three D class submarines and one E boat joined the Home Fleet on manoeuvres in October 1913. They were deployed in pairs on the flanks of the battle squadrons, and claimed one light cruiser and an enemy battleship – greatly encouraging Keyes, who wrote that "submarines... might well inflict a severe loss on the enemy before a general action takes place." [72] But even the D class was too slow to work offensively on the high seas, or with battle squadrons steaming at anything like the 21 knot top speed of the latest Dreadnoughts. There was no possibility the submarines could have worked ahead of the fleet to surprise an enemy squadron.

Hall began to tackle the problem of low speed in his specification for

[67] 'Record of a conference held in the First Lord's room on 9th December [1913]', KP 4/10

[68] Ballard memo nd (?March 1912) KP 4/5

[69] Jon Sumida, *In defence of naval supremacy: finance, technology and British naval policy 1889–1914* (Boston 1989) p.318

[70] Hall memo 'A brief account of the performances of the sea–going flotillas of submarines during the recent strategical exercises in the North Sea' 4 August 1908, FP 4253. By this date Hall expected future submarines to be used in fleet actions – see Hall to Controller 16 May 1908, Adm 116/1057

[71] Keyes memo 3 June 1911, KP 4/13

[72] Keyes to Madden (Rear Admiral, Third Cruiser Squadron) 8 October 1913, KP 4/14

the E class submarine, which was capable of 15 knots on the surface and expected to operate both off an enemy coast and with the British battlefleet. In Keyes's recollection, "it was considered that this type should be capable of accompanying a modern fleet to sea and should possess the highest possible speed for strategic reasons." [73] Like its project to station B and C class submarines off the German coast, the Navy's attempts to force overseas submarines into a fleet role they could not discharge efficiently suggest that strategic thought was being allowed to run ahead of *materiel*; the next class of boat, the Gs of 1913, could manage no more than 14 knots on the surface and it became increasingly clear that contemporary diesel engines could not guarantee submarines the speed they would need to work with a fleet. The largest diesel boats produced during the war, the 1210/1610 ton J class, reached speeds of no more than 19 knots and were never used in operations with surface units.

Keyes's *Nautilus* and *Swordfish* were laid down to test diesels against the only possible alternative: steam engines. Vickers, the only British company with any experience of building diesel engines for submarines, wisely declined an Admiralty invitation to produce a boat capable of a surface speed of 20 knots, and in the end failed in its attempt to build a motor capable of driving the experimental *Nautilus* at 17 knots – three knots below the maximum speed of the Home Fleet at the time. The engines were "considerably overweight", Vickers admitted [74], and even in the machine shop they suffered from excessive vibration and over–heating [75].

Swordfish, built by Scotts to an Italian design, was always intended to be a prototype steam fleet submarine [76], and her design called for a surface speed of 18 knots. The tactical advantages anticipated from fleet submarines also prompted the DNC, ET d'Eyncourt, to produce designs for a much bigger boat in the spring of 1913. D'Eyncourt's steam powered submarine would have had a top speed of 24 knots and displaced 1,700 tons, but by December the design had been rejected on the grounds that it represented too great an advance over existing types. A final decision on

[73] Keyes report 15 August 1913, Adm 138/246C section 49. See also Callaghan's 'Remarks on North Sea Strategy' 28 August 1913, Adm 116/1214

[74] Vickers paper 'HMS *Nautilus*' nd (?May 1918) VP 599 fol.386

[75] Vickers paper 'HMS *Nautilus*' 2 May 1918, VP 599 fol.388

[76] '*Swordfish* type' 11 December 1913, digest cut 11a, Adm 12/1513

the boat was deferred for a year in the hope *Nautilus* might prove the viability of high speed diesel submarines; if the Vickers–designed boat was a failure, it was agreed to order one submarine to the DNC's design as part of the 1914–15 programme [77].

The Admiralty's misgivings were based largely on a realistic appraisal of the shortcomings of steam submarines [see also section 3.2]. Steam boats took so long to close up and dive that the element of surprise needed for a successful attack on an enemy fleet could easily be lost [78]. They were also vulnerable to weather damage, as the steam submarine *Archimede* demonstrated early in the war. The French boat was on patrol with British submarines off Heligoland when her collapsible funnel was struck by a wave, jamming the mechanism for lowering it into the hull and making it impossible for the boat to dive. *Archimede* shipped a considerable quantity of water through her damaged funnel and took two days to stagger out of the Bight in constant danger of attack by German patrols [79]. Hall pointed out a number of other disadvantages: steam engines were difficult to maintain [80], d'Eyncourt's submarine was probably too big to operate successfully in the shallow waters of the North Sea, and her size made her difficult to manoeuvre into an attacking position and an easy target for a counter attack [81].

Both Hall and Keyes were also reluctant to order submarines to work with large surface units. Hall accepted that "the argument that they should be able to gain the right ahead position on the surface is a sound one", but pointed out submarines were "horrible things to have around from [a] big ship point of view". Keyes, who saw his overseas boats in action with the fleet in 1913, "had some very bad moments watching heavy ships,

[77] 'Record of a conference held in the First Lord's room on 9th December [1913]', KP 4/10; ET d'Eyncourt, *A shipbuilder's yarn: the record of a naval constructor* (London nd [1949]) p.88; 'Warship construction during the 1914–1918 war' 31 December 1918, Adm 1/8547/340 pp.216–18

[78] Fisher paper 'The oil engine and the submarine' December 1913 and Esher marginalia, FP 4293

[79] Jameson op.cit. p.144; Kenneth Edwards, *We dive at dawn* (London nd 1939) pp.90–2

[80] Hall to Fisher 14 July 1913, FP 708

[81] Hall to Tudor 16 May 1915, cited in 'Submarine administration', Technical History 21 pp.14–15, Naval Library. "Only the necessity of accompanying the battlefleet justified in my opinion the size of the K class," Hall concluded. See also Don Everitt, *The K boats: a dramatic first report on the Navy's most calamitous submarines* (London 1963) p.31.

cruisers and destroyers manoeuvering in all directions over the submarines" [82], and the risk of misidentification and accident was such that in October 1914 the Admiralty issued orders for boats to keep clear of the fleet and notify surface units of their movements [83].

The real impetus for the development of large submarines therefore came from the Admiralty and senior surface officers. The naval authorities suspected the Germans had stolen a decisive lead in the development of fleet types in the immediate pre–war period; there were reports that the Imperial Navy had built boats with surface speeds of 19 or even 22 knots, and the Admiralty was further alarmed by news that a half flotilla of U–boats had been attached to the High Sea Fleet during the 1913 manoeuvres [84]. By the end of 1915 Jellicoe thought the High Sea Fleet was "quite certain" to be accompanied by underwater craft [85]. He did not learn until after the war that Germany had never given credence to the fleet submarine theory [86].

Both Jellicoe and Beatty were keen to have submarines under their command. In 1915 Jellicoe argued that German deployment of U–boats with the fleet would put him at a disadvantage "if our own submarines are not in a position to take offensive action against the German battlefleet", and when Beatty took over the Grand Fleet he requested the transfer of a minimum of 40 boats to his control [87]. The senior officers of the surface fleet were supported by Keyes – who had been ordered to integrate the submarine service into the fleet and was less concerned than his predecessors by non–specialist 'interference' in the branch – and from 1913 by Fisher, who had anticipated the problems of operating fleet

[82] Hall to Keyes 7 October 1911, KP 4/22; Keyes to de Robeck 10 August 1913, Adm 137/1926. Keyes nevertheless believed the submarines had performed creditably; see Keyes to Madden 8 October 1913, KP 4/14

[83] 'Keeping clear of fleets' 16 October 1914, digest cut 11a, Adm 12/1525

[84] Report on High Sea Fleet manoeuvres dated 16 July 1913, Adm 137/3867. See also Jellicoe to Admiralty 30 October 1914, Add.Mss. 49012 fols.23–5; Tudor memo 'Submarines – proposals in regard to further programmes' 22 July 1915, Adm 1/8428/209; Eberhard Rossler, *The U–boat: the evolution and technical history of German submarines* (London 1975) p.32

[85] Jellicoe to Admiralty 8 November 1915, Adm 137/1926

[86] Reinhard Scheer, *Germany's High Sea Fleet in the World War* (London 1920) p.104

[87] Jellicoe to Admiralty 8 November 1915, Adm 137/1926 fols.48–9; Beatty to Captains (S) 3 January 1917, ibid fols.93–4

submarines as early as 1904 [88] but who refused to let the Germans develop a lead in any sort of warship. Even Hall, encouraged by Fisher, gave his guarded blessing to steam power shortly before the outbreak of war [89].

The fleet submarine concept thus had the approval of a broad spectrum of naval officers by 1914. Despite Keyes's drive to develop workable designs, however, the Admiralty began to realise its overseas submarine programme was of greater short–term significance to British policy. Procurement of E class boats had been cut back to fund experimental designs, leaving the RN without enough patrol submarines to mount a full scale blockade [see section 6.3]. Early in 1914 the Admiralty therefore called a temporary halt to the fleet programme in order to concentrate its resources on building overseas craft; the construction of coastal and patrol submarines was more important than a long–term fleet programme, Keyes conceded [90].

Only the twin spurs of war and rumours of German activity prompted the Admiralty to revive the programme in 1915. D'Eyncourt's 1913 design was dusted off and compared with a specification for a steam submarine drawn up by Vickers. In April 1915 the best elements of the two plans were combined to produce what was to become the K class submarine. Each boat displaced 1,880/2,560 tons on a 340 foot hull and could reach speeds of 24/9 knots – enough to let them operate ahead of the fleet, if not enough to guarantee success under water. The boilers could be closed down for diving in five minutes; the fastest dive ever recorded by a K boat was completed in a – perilously slow – 3 minutes 30 seconds [91].

Orders for 14 fleet submarines were placed in June 1915. A total of 18 Ks were eventually completed, and two flotillas of seven boats each served with the Grand Fleet in 1917 and 1918 [92], replacing E class boats stationed at Blyth as stop–gap fleet submarines [93]. The Ks were a

[88] Cf. Fisher paper 'Submarine boats' nd (c.April 1904), Adm 116/3093

[89] Hall to Keyes 25 September 1913, KP 4/22

[90] Keyes to Churchill nd (late December 1913 or early January 1918) KP 4/11; Keyes report 16 February 1914, KP 4/10

[91] Everitt op.cit. pp.28, 98–9

[92] David Henry, *British submarine development and policy 1918–1939* (unpublished London University PhD thesis, 1976) p.36

[93] Jellicoe to Admiralty 24 July 1915, Adm 137/1926 fols.40–4; Jellicoe to Admiralty 3 November 1915, ibid fol.88

considerable advance on anything that had been tried before, and soon earned a reputation for unreliability. The boats performed poorly in heavy seas, forcing the Admiralty to add distinctive swan bows to lend extra buoyancy. The weight of water on the long, low superstructure sometimes pushed them under, and it was discovered the hydroplanes were too small to control the delicately–balanced submarines in neutral buoyancy. The boats also had a tendency, shared with French steam submarines, to ship water through funnels and ventilators, and some of the numerous hull openings were occasionally jammed in a partially open position by driftwood [94]. Handling such large and unwieldy submarines called for great skill, and from 1916 many of the most experienced British submarine commanders were transferred to the K flotillas, seriously compromising the efficiency of the far busier overseas submarines on the blockade line.

Not all officers were convinced that such boats could work effectively with the fleet. Hall, who had never been keen on the K class, sounded a warning note in 1916 by reporting: "the underwater disadvantages attending the Vessel[s]... are great, and steam is not recommended for reproduction in any class of submarine unless it can clearly be shown that she will be of no use without it." [95] Ernest Leir, the senior submarine officer afloat, thought "the only good thing about K boats was that they never engaged the enemy" [96]. But few went as far as AJ Leveson, the Director of the Operations Division, who in May 1914 questioned the whole concept of the fleet submarine. "As regards the employment of submarines," he wrote,

> "I far prefer that they should be sent on detached service to important positions in the theatre of operations... I always seem to see too great a desire on the part of a good many theoretical strategists and tacticians to bring the latest and newest of every type of vessel and arm, into the Grand Fleet of Battle.
>
> "This has its advantages, but I think gets a bit overdone, especially when it comes to types originated and designed for something else." [97]

[94] Everitt op.cit. pp.95–7

[95] Hall to Admiralty 6 November 1916, Adm 137/1926 fols.626–9

[96] Everitt op.cit. p.109

[97] Leveson note 12 May 1914, KP 4/14

In retrospect, however, Leveson's caution seems justified. The K's 24 knot maximum speed was only just sufficient for fleet work, and they found it difficult to move into the prescribed positions ahead of the line of battle. Once there, their near five minute diving time made it likely they would be spotted before they could submerge, and their nine knot underwater speed meant they could not respond to evasive action by the enemy. In addition, they lacked both the manoeuvrability (surface and submerged) and the control facilities to work with fleet without risking collision. The real danger of wartime operations was conclusively demonstrated when a pair of K class flotillas exercising with the Grand Fleet off May Island at the end of January 1918 lost two submarines, one of them with all hands, and had three damaged, in a terrible series of collisions caused by a jammed helm in *K22* [98]. There were a number of lesser accidents, and *K13* and *K5* were both lost during diving trials (the latter not until 1921). "At the end of the war," wrote Vernon Haggard, "it was recognised fully... that the use of steam in submarines was not a sound policy." [99]

It was perhaps unfortunate for the Royal Navy that though steam power was universally condemned, the fleet submarine concept itself was not discredited. The K class boats never had the chance to prove themselves in action. They joined the fleet after Jutland, and as it became obvious the HSF would stay in port the Ks were detached to operate against enemy submarines, either on patrol or as "interceptors" based at Scapa [100]. The K boats' great size made them poor anti–submarine submarines, but the Admiralty continued to believe they would prove relatively valuable in a fleet role, and thought the submarines were proof Britain "could confidently produce a successful boat of any size or specification asked for and that we have long passed the stage of experimental construction" [101]. One modified K class boat was completed in 1923, and three more fleet submarines, of the River class, were built between 1929 and 1932. The fleet submarine concept was not finally abandoned until the mid–1930s.

[98] Everitt op.cit. pp.109–152

[99] Haggard to Admiralty 22 October 1925, Adm 1/8678/24, quoted in Henry op.cit. p.94

[100] On K class anti–submarine orders, see Beatty Operations Order AA 4 June 1917, Adm 137/1925 fol.21 and Madden order Operation Z 9 June 1917, ibid fol.24

[101] 'Submarine administration' October 1921, Technical History 21 p.6

The post-war restrospect

On 19 November 1918 Germany began the surrender of its 176 surviving U-boats. The submarines were interned at Harwich under Article XXII of the Armistice, and 125 boats building were broken up on the stocks. 40 German submarines were allocated to the Allied powers for use for propaganda purposes, but the main effect of the surrender was to give the Royal Navy, with its 133 boats, an unassailable advantage in numbers and an estimated five year lead in submarine design and development over all other powers [102].

Yet British submarine policy in the immediate post-war period was almost as uncertain as it had been in 1914. Two committees - the Post War Questions Committee and the CID 'Sub-committee to take evidence on the question of capital ship construction in the Royal Navy' (Bonar Law committee) - set up to analyse the lessons of the war and set out future naval policy revealed there was disagreement as to which of the six main types of submarine in service in 1918 should be retained, and some uncertainty over the future of capital ships confronted by the dual threat of submarines and aircraft. And - since Britain's finances were in such disarray the RN would have to be drastically slimmed, and U-boats had proven themselves thoroughly efficient commerce destroyers - the issues were further clouded by the Admiralty's initial determination to have the submarine abolished.

In January 1919 the Board decided to press the naval powers for "a universal prohibition against the building of submarines in future", hoping at the very least to obtain an undertaking not to use boats in an illegal commerce war. It was prepared to order the scrapping of Britain's submarine force to achieve this aim [103].

The Admiralty had the support of the US Navy, which was strongly in favour of strengthening international law as it applied to war at sea, but the British and Americans eventually decided not to press the issue in the face of the combined opposition of the other allies, who argued the

[102] Marder, DSF V, 258-9; Henry op.cit. p.56. The first British post-war scheme called for 94 submarines of the E, G, H21, J, K, L, M and R classes to remain in front line service, while 14 more would be placed in reserve. 'Post-war fleet' 24 January 1919, Adm 1/8549/18 fol.20.

[103] Marder, DSF V, 257; David Henry, 'British submarine policy 1918-1939' in Bryan Ranft, ed., *Technical change and British naval policy 1860-1939* (London 1977) p.80

submarine was a legitimate weapon of war that happened to have been used illegally and pointed out the abolition of such a cheap but potent weapon would unfairly favour the major naval powers. Even the British naval staff argued that the war had shown the RN needed submarines for reconnaissance and to guard its bases, particularly those in the Far East, as well as to provide training for the anti-submarine forces needed in case an enemy ever began to build up its submarine strength again. At the 1921 Washington Naval Conference, therefore, Britain asked only that the powers agree to keep construction of underwater craft within specific limits. Fierce opposition from the French delegates prevented an agreement, although under the terms of the Treaty of Versailles the Germans were denied the right to build any more U-boats [104].

The great lesson of the submarine war, so far as the Admiralty was concerned, was that the submarine was indeed the 'weapon of the weaker power', of less use to the RN than it was to its enemies and a far greater threat to commerce than it was to the surface fleet. Not a single Dreadnought had been sunk by submarines during the Great War, and though the development of underwater warfare had severely limited deployment of the Grand Fleet, it had never been driven from the seas and had continued to operate offensively until November 1918. Moreover the substantial increase in the number of U-boats sunk in 1917 and 1918 - 132, compared to the 46 destroyed in the first two and a half years of the war - suggested that the submarine might now be tamed, if not defeated.

Beatty, who commanded the Grand Fleet for the last two years of the war before going to the Admiralty as First Sea Lord, believed developments in anti-submarine warfare - and in particular the promising ASDIC echo location system - meant "the submarine menace should be kept within measurable limits in any future war." Furthermore, he reminded his colleagues, the Germans had turned to submarine warfare only in desperation:

> "It cannot too clearly be realised that the Germans were forced to undertake the laborious task of attacking our vessels with the submarine on account of their inability to employ surface vessels which

[104] Ranft, op.cit. pp.81-4, 92, 103; Paul Kennedy, *The rise and fall of British naval mastery* (London 1983) pp.268-75

would have accomplished the same amount of work in a far shorter time... it is the Admiralty view that the surface ship still retains an incomparable advantage over the submarine. If, therefore, the command of the sea which has been the outstanding principle of our Naval Policy for the past 300 years is to be maintained, it will be necessary to continue to rely upon surface vessels. It follows, then, that the Capital Ship, which represents the most powerful expression of tactical effect, is also necessary." [105]

Beatty's opinions were echoed in the general conclusions of the Bonar Law committee, which met on a number of occasions in 1920 to take evidence on the question of capital ship construction, and ruled that "there is little to support the contention that the capital ship has been rendered obsolescent by developments in the use of submarines and aircraft, but that no limit can be put on the possibilities of achievement in this direction in the near future." [106] Every serving officer questioned by the committee was adamant that capital ship construction should continue, and most thought new vessels should be laid down immediately. The evidence of a minority of retired officers – including Hall and Rear Admiral Charles de Bartolome, the Controller at the time of the Armistice – who thought the submarine and the aircraft had rendered capital ships obsolescent, was disregarded. Churchill described the minority group as "officers who have left the service without attaining high command... and who are in some cases embittered and in all cases without responsibility." [107]

Hall's argument – that aircraft and submarines could do the job of a capital ship, but more cheaply – was essentially that advanced by proponents of the submarine among second ranking naval powers since at least the time of Robert Fulton. It recognised, as many British officers were unwilling to, that the Royal Navy could no longer hope to maintain any sort of two–power standard and would henceforth have to fight to retain naval parity with the USN, and underlined the former Commodore's faith in the wartime achievements of the submarine branch.

[105] Beatty paper 'The retention of the capital ship' 14 December 1920, Adm 116/3610

[106] Report of the CID 'Sub–committee on the question of the capital ship in the Royal Navy' 29 December 1920, ibid

[107] Churchill note 13 February 1921, ibid

In his evidence to the Post War Questions Committee, Hall agreed that all six major classes of submarine – the patrol, coastal, fleet, monitor, minelaying and cruiser types – would find a place in the ideal navy, but argued that the general purpose patrol boat was most important to the RN as it could also work as a coastal or minelaying submarine. The fleet type, though a success, was highly specialised and no more than one flotilla need be retained. The former Commodore (S) recommended the scrapping of other specialised boats, such as the R class, with the proviso that one or two of each type be retained for experimental work, and was enthusiastic about the performance of the H, L and M class boats – the first two 'perfect' patrol types and the last a monitor submarine developed from the K class but fitted with diesels and a single 12" gun [108]. "The monitor type is the most valuable and most successful submarine we have ever had; it has a very large radius of action and is extraordinarily good under water," he concluded [109].

Hall's evidence reflected the ambiguous results obtained by British boats in the Great War. Patrol submarines had been an obvious success, contributing to what the Admiralty described as 'the most effective blockade in history' and helping to restrict the movements of the German surface fleet, while the limited range and endurance of older types, plus their inability to intercept raiding forces, made it seem unwise to persist with purely coastal designs. But British torpedoes – designed for optimum short range performance rather than efficiency at the longer ranges more usual in wartime [110] – had failed on numerous occasions and had never delivered a knock–out blow to a modern capital ship. Wartime submarines had been given the maximum possible bow torpedo armament in an attempt to compensate, but the 12" gun of an M class submarine offered more range than a torpedo and could be used from a semi–submerged position to attack enemy merchant vessels and small warships. The shell could not be spotted or avoided as a torpedo could be. Hall even anticipated its use against enemy battlecruisers, though he admitted that "a single 12 inch shell will not stop them." [111]

[108] See Henry, *British submarine development and policy 1918–1939* (unpublished London University PhD thesis, 1976) pp.42–8; Jameson op.cit. pp. 159–60

[109] Hall evidence to the Post War Questions Committee nd (1920), Adm 116/2060 fols.726–38

[110] Hall evidence, ibid fol.730. On the British blockade, see Admiralty paper 'The British naval effort 1914–1918' 24 December 1918, Adm 1/8547/336 pp.6, 9

[111] Hall evidence, ibid fol.737; HMS *Vernon* annual report 1917, Adm 187/37 pp.24–5.

The principal drawbacks of the M class design – the difficulty of guaranteeing a hit from a single shell, the fact that a hit above the waterline could not match the devastation caused by a torpedo, and the semi-submerged submarine's vulnerability to a counter attack – were never exposed in action. Nor were the faulty tactics of the fleet submarine, at its most vulnerable operating in close formation in support of a fleet and unlikely, with its five minute diving time, ever to get into position early enough to attack an enemy formation from beneath the surface.

Even the benefit of hindsight does not appear to have helped naval officers to appreciate the difficulties submarines created when operating with the surface fleet. Both the Battle of the Heligoland Bight and the so-called Battle of May Island demonstrated not only that underwater craft risked being accidentally rammed by surface units manouvring at high speed, but also that they actively disrupted operations because they were frequently impossible to distinguish from enemy U-boats [112]. Equally importantly, high speed surface actions gave submarines little chance to make the sort of deliberate attacks most likely to bring success. Four years of war proved nothing more decisively than that underwater craft were weapons of opportunity whose low submerged speed gave them little chance of making a second attack if their first was unsuccessful.

Although submarines might – in theory at least – make some small contribution to the success of a fleet action, their tactical value was altogether less significant than their influence on the strategy of the naval war. British patrol flotillas were largely responsible for keeping the High Sea Fleet in port and maintaining a blockade that not only guaranteed Allied supply lines against enemy surface forces but also had a devastating long-term effect on the economies of the Central Powers. In addition, British and German submarines exercised a 'moral effect' so potent, so restrictive, that the Great War at sea was absolutely distinct from any naval war that had preceded it.

Although Hall's flotillas had little chance of equalling the impact made by German U-boats, the achievements of British submarines should not be under-estimated. They exercised considerable influence not just on the main campaign in the North Sea, but also in the Baltic and the

[112] Ranft op.cit. p.91; Richard Compton Hall, *Submarine warfare: monsters and midgets* (Poole 1985) pp.31-43

Mediterranean. They helped to prolong the Gallipoli campaign and offered considerable assistance to the Russians. Without wishing to denigrate the efforts of the Russian Baltic Fleet, which is rarely treated fairly by Western historians, it is not too much to suggest that the nine boats of the British Baltic flotilla had more effect on the naval war than any similarly-sized group of Allied, and perhaps also German, warships.

In the absence of more effective anti-submarine weapons, British boats also made an impressive contribution to the desperate war against the U-boats. Despite the handicap of inadequate detection apparatus and poor quality torpedoes, they sank 17 enemy craft for the loss of only five of their own number. Perhaps more significantly, the moral effect of the Trade's anti-submarine patrols contributed something to the mental strain on U-boat crews, particularly in 1917 and 1918.

The submarine branch's contribution to the war effort was nevertheless secondary to that of the surface fleet. Both the Admiralty and the public gave the Grand Fleet credit for the British victory at sea in World War I, and despite the rapid development of the aircraft carrier the battleship remained the principal instrument of naval policy in the 1920s. The submarine was peripheral to RN strategy, and according to David Henry, "the Submarine Service was faced with the obstacle of a far greater restraint on resources for construction and development than any other category of warship" in the inter-war period [113].

Restrictions were inevitable because the Royal Navy failed to integrate the submarine fully into its strategic thought either during or after World War I. Some lessons had been learned. The Admiralty was forcibly convinced of the true radius of action of the modern boat - one German coastal craft of the tiny 127/142 tonne UB class reached the Azores in the course of a 33-day cruise, and overseas submarines operated successfully off the east coast of the United States [114] - and confidence in the seakeeping and endurance of the latest types fuelled RN willingness to depend on submarines to defend its Far Eastern interests from the 1920s. The importance of personnel, as well as *materiel*, also emerged clearly from the war, as Hall had always insisted it would. Although 150 British boats served in the Great War, sixteen captains accounted for all the

[113] Henry op.cit. p.80

[114] Jameson op.cit. pp.210, 247

warships sunk by Royal Navy submarines, while 22 of the 400 U-boat commanders accounted for over 60 per cent of Allied losses of merchant vessels [115].

The qualities of the British diesel engined overseas type were recognised, and from 1918 there were no more experiments with foreign boats. The overseas submarine was the only type of underwater craft to be consistently developed by the RN between the wars, and the S, T and U class boats that formed the backbone of the submarine branch in World War II – though double-hulled and incorporating the best features of continental designs – were recognisably the descendants of the E and L class craft of the Great War [116]. The wartime success of Britain's extemporised E class minelaying submarines also encouraged the development of specially designed *Porpoise* class minelayers [117].

During the inter-war period considerable effort was nevertheless devoted to the piecemeal development of specialised submarines – including the monitor and fleet types – incorporating the more desirable features of surface warships. None of these submarines added substantially to the Navy's strength in the long term and all had been abandoned by 1939. They were built because the RN rarely thought of the submarine as a distinct type of warship. The original Holland craft were 'submarine torpedo boats'. The Ks were 'diving destroyers', the M class 'submarine gunboats'. They were expected to adopt the tactics of the torpedo boat, the destroyer, the monitor – and this made it all too easy for the Navy to forget that underwater craft had unique potential of their own. In 1918 and 1939, as much as in 1900 or 1853, the submarine posed more questions for British policy than it answered.

British submarine policy 1901-1918

The British submarine branch developed extremely rapidly between 1901 and 1918. It began the period with six *Hollands*, a hundred men and a minor

[115] Hall report 30 August 1916, Adm 137/2077 fol.68; Hall introduction to WG Carr, *By guess and by God: the story of the British submarines in the war* (London nd (1930)) p.ix

[116] Henry op.cit. p.106

[117] Ibid pp.155-6, 179-80

place in Royal Navy's scheme of coastal defence. It ended it as the world's largest submarine service, with 133 boats, 6,000 men and a considerable lead in design and development over all other powers. The latest types were more than three times faster and no less than seventeen times the size of HM *Submarine Torpedo Boat No.1.*

British submarine policy did not evolve as quickly as the British submarine. Underwater craft seemed to have no place in the traditional offensive strategy of the Royal Navy, which called for mobility and the maximum offensive potential, and they had originally been developed as a means of attacking the dominant naval power and not to bolster the position of a navy dependent on a large surface fleet. Although enthusiasts, such as the Parliamentary Secretary to the Admiralty, HO Arnold-Forster, argued that "the submarine cannot correctly be called the 'weapon of the weaker power', because the Power that possesses it, necessarily becomes the stronger power" [118], the majority of naval officers did not understand underwater craft and showed little enthusiasm for them at the turn of the century. Some doubted that the RN needed submarines, and most thought of them as defensive weapons of limited range.

The Navy had very little time to come to grips with the modern submarine. It had to fight a war only twelve years after its first boat was commissioned. The Germans did not take delivery of *U1* until 1906, and put their first long-range offensive types into service as late as 1912. Neither the French navy, with its chaotic, ever-changing submarine policy, nor the pioneering Russian and American fleets, seemed to have much to teach the Royal Navy about underwater warfare, and the Admiralty had to rely upon its own - flawed - manoeuvres and exercises to assess the submarine.

It was difficult to exercise boats with the fleet. Rigid safety rules were introduced after the *A1* was sunk during the 1904 Spithead trials, and submarines did not participate in the manoeuvres of 1905, 1906, 1907 and 1909. When they did exercise with surface ships, they were accompanied by tenders flying a red flag, and had to display two feet of periscope at all time. If a submarine came within 1,000 yards of a surface ship, she had to surface. The naval manoeuvres, which were the only occasions on which

[118] Arnold-Forster to Selborne 8 August 1901, Arnold-Forster papers Add.Mss. 50294 fol.6

the majority of officers encountered submarines, thus gave a very distorted impression of their capabilities.

A number of additional factors combined to complicate assessment. The submarine branch was a closed service, commanded for its first ten years by individualists who gladly took the opportunity to develop a semi-autonomous force with little contact with the surface fleet. The Admiralty - which had to deal the emergence of a new enemy, Germany, and the creation of entirely new classes of battleship and cruiser - rarely interfered with the development of submarine design and tactics, and Keyes, instructed in 1910 to "bring the submarine service into close touch and co-operation with the fleet" found himself in command of "a highly selected body of officers and men, credited in the Navy generally with an inclination to regard themselves as almost a seperate service." [119] By entrusting the development of *materiel* and tactics to the technical specialists of the Trade, the Royal Navy effectively ensured that its submarine service would be technology-driven rather than strategy-driven for the first ten years of its existence.

Most of the British submarines available in 1914 betrayed their origins as coast defence boats developed by a branch more concerned with technical problems than strategic planning. The size of the C, D and E classes was limited because they were expected to operate in shallow coastal waters, and performance - particularly diving time - reflected the expectation that submarines would work in friendly rather than enemy waters. The results of highly artificial torpedo firing-trials suggested that a substantial proportion of hits could be expected, and British boats therefore mounted only a limited number of torpedo tubes. The Vickers diesel - probably the single most important technological advance made before the war - was adopted because it was safer and more efficient than the old petrol engines, and not because it also offered substantially improved endurance. Each of main classes of submarine, from the Hollands to the E class was, in short, was a multi-purpose type designed to take advantage of the latest developments in technology rather than to fill a specific strategic role.

Not until Roger Keyes took command of the submarine branch in 1910 did the service switch from being technology-led to being strategy-led.

[119] Keyes NM I pp.23-5

Keyes's determination to experiment with foreign designs, and in particular his attempts to produce a workable fleet submarine with the surface speed to operate ahead of British battle squadrons, helped to integrate the submarine branch with the fleet. It also pushed design to its limits and diverted attention from the overseas type, which was criticially important in maintaining a blockade of German ports and fulfilling vital patrol and reconnaissance roles in enemy-controlled waters. Although Keyes developed his own patrol type, the G class submarine, he cut back sharply on the proven E boats in favour of placing orders for what his predecessor, Hall, termed "freaks and coastals" [120].

With the exception of the G class itself, none of the submarines ordered by Keyes proved of much use to the Navy in World War I, and the K class fleet submarine – developed with the encouragement of an Admiralty obsessed with the idea of operating underwater craft in conjunction with the surface fleet – never came into action. Because Keyes and the naval staff down-played the dangers of working submarines close to large surface units, and because the Ks were both too large and too slow when submerged to be truly effective, the fleet submarine concept was pursued for years with little chance of real success, and at the expense of the overseas submarine programme.

Keyes was able to impose his own strategic ideas on the submarine service both because he had the full backing of most of the branch's junior officers and the support of key figures at the Admiralty, and because formulation of policy depended, particularly in the early years of the service, chiefly on the assessments made by submarine officers themselves. Bacon's reports of 31 May 1903 and 16 January 1904, which concluded that the submarine should operate as a coast defence weapon, formed the basis of the Admiralty's submarine strategy until 1908-11, when the development of the D and E class 'overseas' submarines suggested other uses for underwater craft. The Admiralty war staff's 1914 decision to use submarines to maintain a blockade of the enemy coast – giving the Germans one of the major strategical surprises of the war – did not altogether find favour with the officers of the submarine branch, who understood the limitations of their existing boats and still harboured doubts about their reliability.

The British submarine blockade – though neither 'close', continuous nor

[120] Hall to Fisher 26 April 1914, FP 803

complete – did exercise a decisive 'moral effect' on the activities of the German fleet. The submarine's elusiveness gave it a psychological value that far outweighed its actual effectiveness, particularly in the early years of the century. Bacon noted that "if *no* boat is sighted, the terible danger exists of being attacked by an unseen enemy. If *one* boat is sighted it is merely an assurance that others are near. No ship will, in Naval wars of the future, be at sea without some definite purpose in view." [121]

Nevertheless, the tendency of non-specialists to think of submarines as defensive weapons helped to blind them to the substantial endurance of the more modern classes. Germany's *U1* had a theoretical radius of action of 750 miles, and the latest type available in 1914 – the *U27* class – one of 10,000 miles [122]. British experience suggested, however, that crew endurance of the uncomfortable conditions on board was restricted to three to four days in a coastal submarine and no more than a week in the larger overseas types. The Admiralty therefore doubted that U-boats would be able to operate effectively off the British east coast, and certainly did not expect to encounter them off northern Scotland or in the Atlantic. This, together with the financial constraints imposed by a government forced to pay for the dramatic expansion of the Grand Fleet, caused the RN to take few precautions against submarine attacks on British bases. A similar tendency to judge the submarine on what it was, rather than on what it might become, contributed to the Admiralty's failure to develop effective anti-submarine weapons and tactics before 1914.

Neither the British nor their enemies expected submarines to be used in a war against commerce. They were too small to carry a prize crew, and too slow and vulnerable to risk a counter attack by their intended victims. International law forbade them to attack without warning. Only desperation, and disgust at Britain's own flouting of the law of 'stop and search', prompted the Imperial German Navy to launch its unrestricted submarine war on commerce in 1915.

Britain's first real fleet submarine, laid down in the same year, met the RN's long standing demand for a seagoing torpedo vessel. Strategically, the K class boats were what the Navy had always thought submarines should be: large, fast, seaworthy (after a fashion), and capable of participating in a decisive battle. Tactically, though, they were a nonsense, combining the

[121] Bacon report 31 May 1903, Adm 1/7725

[122] Rossler op.cit. p.328

worst defects of the submarine as a type. Though fast, they were not fast enough to work far ahead of the fleet. Though well–armed, they took so long to dive they sacrificed the advantage of surprise. With their limited bridge and control room facilities, they were almost as likely to torpedo friendly vessels as the enemy. Worst of all they were slow and unwieldy when submerged, and could not work with a fleet without running a serious risk of collision. In 1915, the Navy finally produced the submarine it had always wanted – and found it wanted something else.

The submarine did, however, exert a decisive influence on other areas of naval strategy. It influenced the development of a new class of fast capital ship, the battlecruiser, which Fisher believed was the only major surface unit capable of evading a submarine torpedo attack. Its performance in the manoeuvres of 1912 and 1913 prompted the Admiralty to develop tactics for screening the battlefleet with destroyers, fundamentally altering the TBD's strategic role and limiting the Grand Fleet's radius of action to that of its escorts. Most significantly of all, fear of falling into a 'submarine trap' forced the commanders of both the Grand Fleet and the High Sea Fleet to manoeuvre with extreme caution. The southern half of the North Sea became a naval nomansland, festooned with mines and infested with torpedo craft, and the war at sea developed into a stalemate to the benefit of Great Britain but to the detriment of morale in the Grand Fleet. "There can," wrote the First Sea Lord, Rosslyn Wemyss, "be no naval officer who does not see the end of this war with a feeling of incompleteness." [123]

Scott Russell's submarine, built in 1855, was little more than a death trap: oar powered, open–bottomed, practically unarmed. The latest submarines available to the Royal Navy in 1918 – those of the L50 class – were formidable boats by any standards, displacing 890/1070 tons, capable of 17.5/10.5 knots and armed with six 21" torpedo tubes. They had been created in the space of only 16 years by a Navy with no real practical experience of submarine boats, but by one that had had a submarine policy since the mid 1850s. Only the continuity of naval policy, and the quality of RN personnel, can explain the remarkable development of the British submarine service after 1900.

[123] Wemyss to Beatty 14 November 1918, quoted in DSF V, 188

Appendix 1

Robert Fulton's British submarine designs, 1804–06

The introductory section to section 1 dealt very briefly with Robert Fulton and his negotiations with the French and British navies early in the nineteenth century. Fulton's exploits, and the details of his advanced submarine designs, have been well documented by a number of historians – but despite the Admiralty's apparently categorical rejection of the inventor's plans, at least one historian has suggested it is possible that the British *did* build a boat to his design, at Lymington late in the summer of 1804 [1].

Since Fulton's most recent biographer asserts that the RN finally discarded his proposed submarine some time in June of that year [2], evidence for the existence of a British submarine at this date remains confined to passing references to 'plungers' (tentatively equated with 'plunging boats') in the correspondence of Admiral Lord Keith. In one passage the distinguished naval officer Sir Home Popham writes from Lymington Creek, whence he had been sent to supervise preparations for a raid on the French invasion fleet: "My Lord, you are so well aware of the difficulties which generally arise in proposing any new mechanical operation, particularly in our dockyards, that you will not be surprised to learn that I could not get a plunger made until Saturday morning" [3]. In another, he

[1] Christopher Lloyd, *The Keith papers*, III (London 1955) p.7

[2] Wallace Hutcheon, *Robert Fulton: pioneer of undersea warfare* (Annapolis 1981) p.71

[3] Home Popham to Keith 12 August 1804, cited in Lloyd op.cit. p.85

states that he "found it much better to row the plungers with two pairs of sculls" [4].

It is, thus, apparent that while Home Popham's 'plungers' were boats of some kind, it is unlikely in the extreme they were submarine boats. The speed of construction suggested by the first passage (notwithstanding complaints about dockyard delays) is against it, as is the clear reference to oars. (All four submarines designed by Fulton in the period 1797–1813 used screw propulsion.) From the context of Home Popham's first letter, it appears more likely that 'plungers' were the cutters used to deliver Fulton's 'New Curiosities' (mines) during the so–called Catamaran Expedition to Boulogne on 2–3 October 1804, and which the inventor later specifically described as "rowboat[s]... clinker–built" [5].

The most recent research into Fulton's stay in Britain has nevertheless uncovered the inventor's plans for two successors to the *Nautilus*. The first of these boats, a tiny one–man submarine to be called the *Messenger*, was designed during the inventor's first months in Britain. She would have carried only one man, and in Fulton's sketches bears some resemblance to the *Holland I* of 1878. A much more sophisticated second boat was never named but was designed to sustain a crew of six for up to 20 days at sea. At 35x10x8' she would have been rather larger than the *Nautilus*, and Fulton's sketches show her carrying two sails. She was evidently designed for optimum sea–keeping on the surface, and in side view looks something like one of Simon Lake's much later submarines [6]. Indeed the inventor's plans suggest that his 1806 craft was probably more sophisticated than any submarine designed in Britain before the mid–1850s.

[4] Home Popham to Keith 17 August 1804, ibid p.86

[5] Hutcheon op.cit. pp.75–8

[6] Ibid pp.71–2

Appendix 2

'On His Majesty's Secret Service': Tom Johnson and the first British submarine, c.1812–1828

There is a story that one of Robert Fulton's British collaborators was the privateer captain and Channel pilot Thomas Johnson [1]. Johnson (1772–1839), a Hampshire man familiarly known as 'the Famous Smuggler' in his day, now inhabits the shadowland between folklore and verifiable history. His association with Fulton is folklore, though there may well be truth in it; his interest in submarines, however, must be regarded as established fact.

A contemporary source [2] suggests that 'Captain' Johnson first approached the British authorities with the plans for a submarine in 1812, demonstrating a clockwork model of the proposed boat to them. Something of the sort must have occurred, for by October 1813 the smuggler had armed himself with letters of security from the Admiralty, the Army and the Home Office, and was formally employed "on His Majesty's Secret Service on submarine, and other useful experiments by Order." [3]

Captain Johnson's real authority came not from the Admiralty but from Horseguards Parade. In the autumn of 1813 he obtained an interview with the Commander–in–Chief, Frederick Duke of York, receiving his verbal sanction to go ahead with the project. Johnson had less success with the ever–sceptical Royal Navy; his meeting with Lord Henry Paulet ended on a

[1] Tom Pocock, 'The Chelsea submarine', *Chelsea Society report* 1984 pp.40–5

[2] John Brown, *Historical gallery of criminal portraiture* (2 vols, Manchester 1823), II, 495

[3] Security from Lord Sidmouth 15 October 1813, enclosed in Johnson to Admiralty, nd (?July 1815), PRO J letter no.206, Adm 1/4783

dispiriting note with the information "that their Lordships could not agree with his proposal, and that they would not give Mr Johnson any further trouble upon the business." [4] In 1815 the projector was reminded by letter that he had "no authority from their Lordships for carrying out... experiments... or for incurring any expense thereon." [5]

The Famous Smuggler decided to press ahead nevertheless. Securing the help of an engineer on High Holborn, he designed a submarine "in shape much like a porpoise." She was 27 feet long, with a beam of 5 feet, and was 5 feet deep towards each pointed end; wrought iron armour covered the hull, protecting a six foot square inner chamber, lined with cork and wood, which housed the 2–man crew.

Like Fulton's submarine, the new vessel was propelled by a collapsible sail while on the surface; dived, however, she was to be driven along by oars. Mention of air–pipes and of armour "proof against 12–pounders at point–blank range" suggests that her submersible qualities were rather limited. Captain Johnson armed her with a gunpowder mine which he probably intended to drive against his target's bottom with the auger favoured by Bushnell and Fulton, but which may at times have been mounted on a spar. The boat's submerged endurance was estimated at 12 hours [6]; the inventor had had her fitted with cylinders of compressed air [7].

The submarine was built on the Thames near Wallingford. She was well advanced in 1814 and nearly complete a year later. In July 1815 the owner "reported being ready with it for experiment", and took the opportunity to request an advance payment of £2,000 [8].

It was, in fact, the lure of money that prompted the whole project. Captain Johnson seems to have got wind of the fabulous payments and assurances made to Robert Fulton, and hoped to secure a similar fortune for himself. Johnson's patron the Duke of York had been in close touch with the American submariner, and was probably aware both of the

[4] Johnson to Admiralty nd (?July 1815); and minute by Paulet nd (?July 1815), ibid

[5] Admiralty to Johnson 8 July 1815, Adm 2/919

[6] This and the above details from the *Naval Chronicle* (1814) p.287; Brown op.cit.; Pocock op.cit.

[7] Arthur Morris, 'A boom in submarines', *Nautical Magazine* 71 (Sept–Oct 1902) p.563

[8] Johnson to Admiralty nd (?July 1815), Adm 1/4783

Admiralty's agreement to pay him a salary of £200 a month, plus £40,000 for the first ship destroyed by his system and half the supposed value of each subsequent vessel sent to the bottom [9], and of Fulton's own demand to Pitt and Castlereagh (9 August 1805) for £100,000 to secure his future silence [10]. Tom Johnson's own plan was therefore to build and test another submarine: "the effects being proved a report to be made thereon, so as to ground an application to Parliament for a remuneration of £100,000, or such sum as may be judged adequate in proportion to its importance." [11]

That the submarine was ever built is, in retrospect, rather astonishing; that the authorities eventually paid for her is little short of remarkable. Johnson raised the necessary money by mortgaging his property, hoping to be handsomely rewarded for his trouble. He had, however, misread the situation, and the outcome of the business was for a long time problematical.

Johnson was ultimately able to take advantage of the sort of communications failure not uncommon in wartime. What probably happened was this: in 1813 Britain and America were at war. Fulton had returned to the United States and was devoting his energies to well-publicised experiments in torpedo warfare. Knowing this, and possessing few details of a system reputed to be highly effective, the Duke of York gave his general approval to the smuggler's suggestion that he develop some sort of counter-measure or counterpart. (If Johnson could prove he had himself worked with Fulton, his task would have been easier, of course.) Armed with the Duke's security, Johnson next visited the Admiralty and the Home Office, where production of Frederick's note was sufficient to provide him with similar documents from those departments. (The latter two securities are dated 15 October to the Duke's authority of the 14th.)

It is quite possible that none of the signatories intended to pay for the Famous Smuggler's experiments – perhaps all assumed that he would meet the costs himself, perhaps each believed that another department had taken responsibility. But whatever the truth, the project was undoubtedly a

[9] Fulton's agreement with the Admiralty 20 July 1804, Adm 1/5121/22

[10] Wallace Hutcheon, *Robert Fulton: pioneer of undersea warfare* (Annapolis 1981) pp.90–1

[11] Johnson to Admiralty nd (?July 1815), Adm 1/4783

maritime one and the Admiralty's letter denying liability (based as it was on a verbal warning to Johnson) had no legal force when set against the inventor's written proof that he was employed "by His Majesty's Government".

Faced with this awkward situation, the Navy had no option but to settle the matter as quickly and as cheaply as possible. In January 1820, Sir George Cockburn joined a committee appointed to examine the submarine and state its "opinion of the actual cost of the said vessel." [12] (Johnson had, presumably, submitted an obviously-inflated bill.) The Sea Lord assessed the boat's value at £4,538, and this sum was paid to the inventor - a portion of the total being retained until the smuggler returned some government stores. There is absolutely no evidence that the Admiralty seriously considered the submarine as a warship; the Navy's real opinion of the whole project is best suggested by the close scrutiny given to a subsequent invoice for the floating cradle used to transport the boat down the Thames to London; this bill was shaved from £216 7s. 6d to £197 11s. 6d. before it too was quietly settled [13]. Johnson's total remuneration therefore amounted to £4,735 11s. 6d. - a far cry from the £100,000 he had hoped for, but a very respectable sum for the time.

The Famous Smuggler had no real cause for complaint; there is no record that the Admiralty paid any other projector more than his incidental expenses in the whole period under review (1793-1900). To Johnson too belongs the signal honour of being the first Briton to construct a submarine [14]. For this alone he deserves to be remembered.

The evidence suggests that Tom Johnson retained an interest in the possibilities of submarine warfare (military *and* commercial) after his account was settled in April 1820. Eight years later we find the 56

[12] 'Report from Sir George Cockburn...' 10 January 1820, digest cut 59-8, Adm 12/198. The original report has, sadly, disappeared.

[13] Johnson to Admiralty 28 March 1820 and enclosures, PRO J letter no.48, Adm 1/4787; Croker minute 3 May 1820, ibid

[14] Before assessing other contenders for the honour, it is necessary to define the term 'submarine'. This I take to mean a vessel capable of submergence and of independent movement when submerged. By these criteria the vessels of Nathaniel Symons (1747) and John Day (1774) were not submarines, since they were capable of no more than submerging and (sometimes) of then returning to the surface. Cornelius Drebbel, who is traditionally said to have built a sumbersible rowing boat in London c.1620, was a Dutchman. For further details of these and other projects see (eg) William Jameson, *The most formidable thing: the story of the submarine from its earliest days to the end of World War I* (London 1965) pp.20-6. On Drebbel, see Alex Roland, *Submarine warfare in the age of sail* (Bloomington, Indiana 1976) pp.18-31; typescript paper in RN Submarine Museum A1985/26. On Day, see RN Submarine Museum pamphlet A1774/1.

year–old smuggler renewing his approaches to the Admiralty, to be rebuffed in short order [15]. And (if the secondary sources are to be believed), the British government was not the only one to which he offered his unusual services.

There are several other accounts – invariably brief – of Johnson's submarine. I will summarise them here for the sake of completeness, to suggest the kind of material found in the popular histories, and because these early works are broadly accurate, although unreferenced. I have been unable to verify the details, but a thorough search of contemporary newspapers might well yield further information. There is no mention of Johnson or his submarine in *The Annual Register*, the *Gentleman's Magazine* or *Palmer's Index to The Times* (1812–21), although *The Annual Register* printed his obituary in 1839.

The noted naval historian William Laird Clowes says that the Admiralty did experiment with the submarine. "On one occasion," he writes, "the boat, a small one, got foul, while submerged, of a ship's cable, and stuck fast. Johnson calmly pulled out his watch and said to his assistant: 'We have but two minutes and a half to live, unless we can get clear of that cable.'" They did get clear, "owing to Johnson's coolness and presence of mind." [16] There is, unhappily, no suggestion in the Admiralty records that any such official trial took place.

Clowes and others assert that French Bonapartists then became interested in Johnson's scheme. According to Clowes, the smuggler was offered £40,000 for his boat, and a further huge sum if he would use her to rescue Napoleon from St Helena. Colonel Cyril Field [17], who has the same story, describes the submarine intended for the business as a vessel 100 feet long powered by two collapsible sails. She was intended to make the passage south on the surface, submerging for the last few miles to make a secret rendezvous on the shore. It was, allegedly, only the Emperor's death (5 May 1821) that put a stop to the plot [18].

[15] 'Mr Thomas Johnston' 19 April 1828, digest cut 59–8, Adm 12/255

[16] William Laird Clowes, 'Submarine boats', *United Services Journal* II (1888–89) pp.286–7

[17] Cyril Field, *The story of the submarine* (London 1908) pp.76–8

[18] It would be interesting to know what Sir George Cockburn thought of this story. As Admiral commanding the *Northumberland*, he had been the man responsible for putting Napoleon on St Helena in the first place.

The only account we have of the fate of Johnson's craft does suggest that she was latterly intended for illicit purposes. According to the memoirs of the Chelsea artist Walter Greaves, his father remembered how "one dark night in November" [?1820] the Famous Smuggler was intercepted as he attempted to run the boat down the Thames for his French masters: "Anyhow she managed to get below London Bridge, the officers boarding her, Capt. Johnson in the meantime threatening to shoot them. But they payed no attention to his threats, seized her and, taking her to Blackwall, burned her." [19]

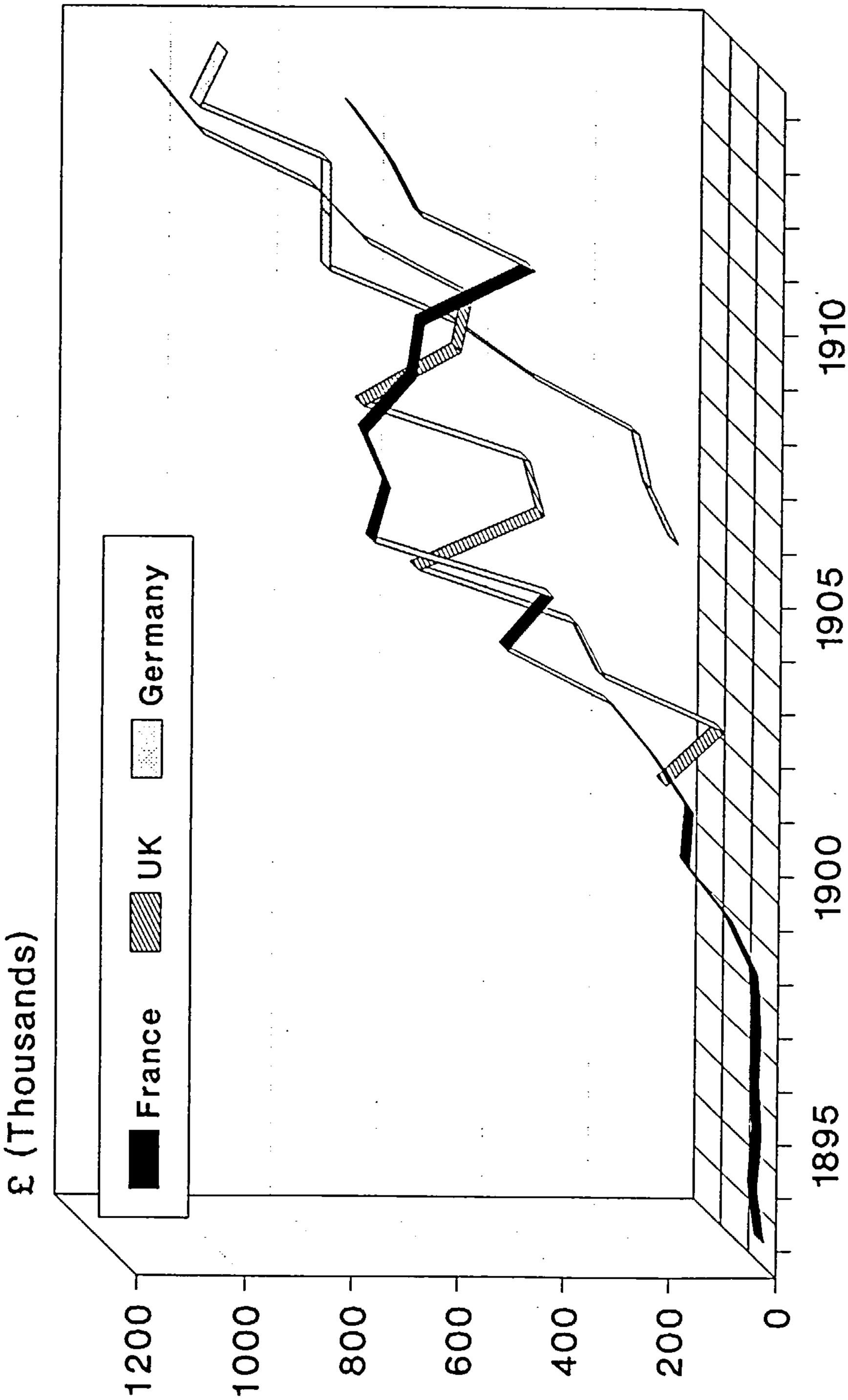
Not easily deterred, Tom Johnson continued his researches in the 1820s. Clowes and Field have him exhibiting another submarine – perhaps a model? – on the Thames in 1823. She was intended for the relief of Cadiz, then besieged by the French. Geoffrey Moreley, author of a work on smuggling in the Hampshire region [20], suggests that Johnson took a submarine built for Spain down the Thames to Blackwall in the spring of 1822. The boat was lost during a diving trial after she had run into some submerged cables. (This seems to be a variation on the stories told by Greaves and Clowes, but it is impossible to say which version is more accurate.) Pocock mentions other projects: a submarine for the King of Denmark, a boat for salvage work off the Texel or for wrecking in the Caribbean. These are, perhaps, no more than the sort of stories one would expect to spring up around as glamorous a figure as Captain Johnson, and it would be unwise to take them at face value. Given his difficulties with the Admiralty, however, it is always possible that Johnson spread the rumours deliberately, in the hope that the authorities would buy him off [21]. The Blackwall burning may have been the Admiralty's response to blackmail.

[19] Pocock op.cit.

[20] Geoffrey Morely, *Smuggling in Hampshire and Dorset 1700–1850* (Newbury nd) pp.33–41

[21] Certainly Johnson used precisely this method in 1828, informing the Admiralty that two other Powers had shown strong interest in his invention, and that his poverty would compel him to negotiate with them if the British authorities continued to ignore him. Admiralty rough minutes 19 April 1828, Adm 3/216.

Appendix 3


Total submarine estimates
for major European powers
£ (Thousands)
France
UK
Germany
1200
1000
800
600
400
200
0
1895
1900
1905
1910
Year

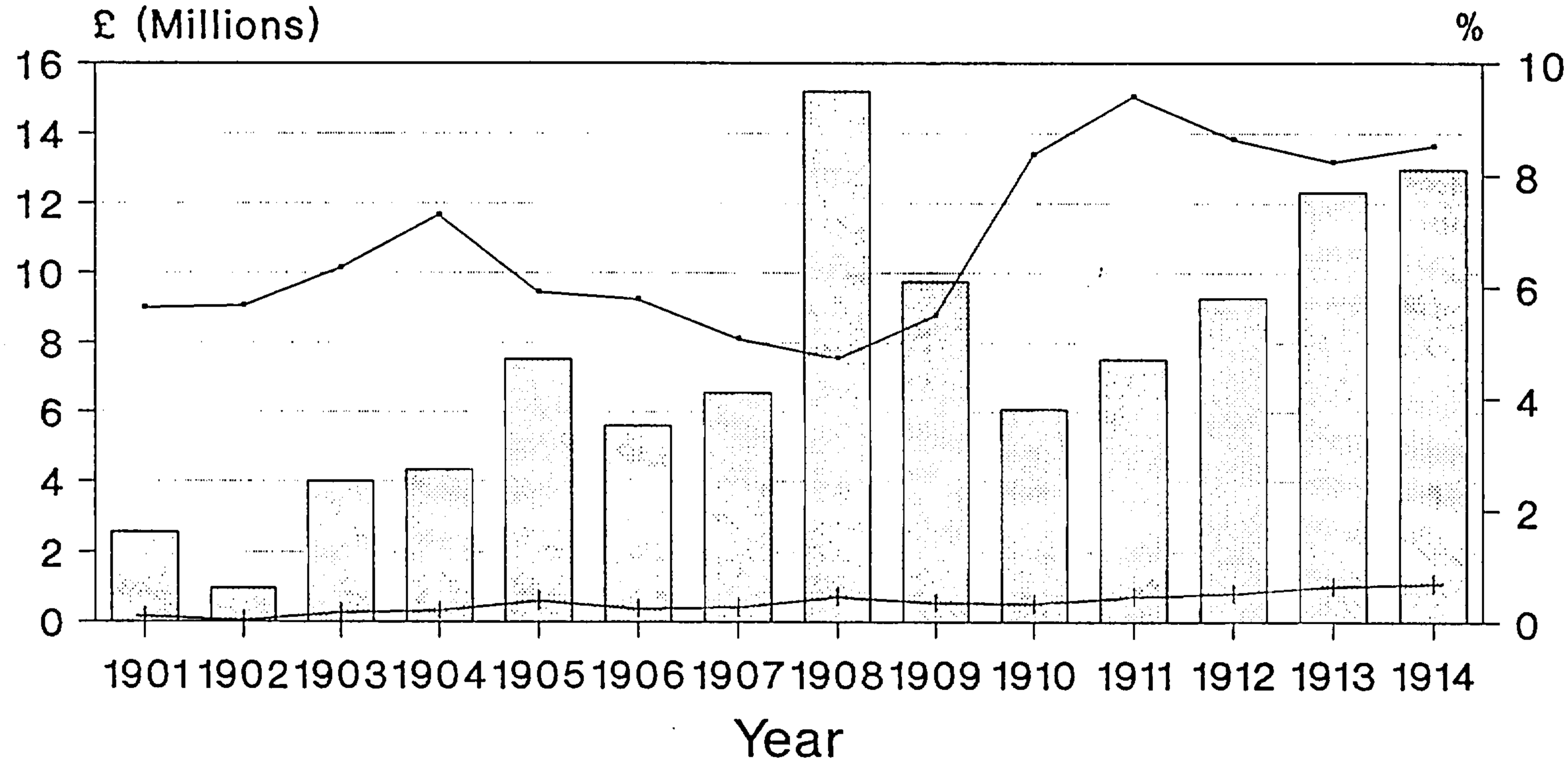
CONSTRUCTION ESTIMATES OF THE MAJOR POWERS 1893 - 1914

YEAR	GREAT BRITAIN			FRANCE			GERMANY		
	TOTAL NEW CONSTRUCTION	SUBMARINE ESTIMATES	SUBS AS %	TOTAL NEW CONSTRUCTION	SUBMARINE ESTIMATES	SUBS AS %	TOTAL NEW CONSTRUCTION	SUBMARINE ESTIMATES	SUBS AS %
1893				£1,849,205	£ 6,000	0.3%			
1894				£2,787,219	£ 19,487	0.7%			
1895				£3,474,571	£ 11,547	0.3%			
1896				£3,571,530	£ 17,220	0.5%			
1897				£2,457,089	£ 13,493	0.5%			
1898				£3,071,376	£ 19,213	0.6%			
1899				£3,168,652	£ 67,109	2.1%			
1900				£2,939,000	£149,244	5.0%			
1901	£ 9,003,256	£ 142,238	1.6%	£2,937,005	£141,899	4.8%			
1902	£ 9,058,520	£ 34,510	0.6%	£3,087,304	£211,241	6.8%			
1903	£10,136,430	£ 259,898	2.5%	£3,564,000	£295,482	8.3%			
1904	£11,654,176	£ 311,246	2.7%	£3,565,600	£494,512	13.8%			
1905	£ 9,451,259	£ 610,830	6.4%	£3,633,880	£408,018	11.2%	£3,281,936	£ 73,422	2.2%
1906	£ 9,252,131	£ 376,502	4.1%	£3,606,846	£747,744	20.7%	£3,564,617	£122,370	3.4%
1907	£ 8,113,202	£ 404,630	5.0%	£3,030,400	£717,740	23.5%	£4,024,971	£146,844	3.6%
1908	£ 7,547,507	£ 718,605	9.5%	£3,282,440	£763,340	23.3%	£5,334,313	£342,636	6.4%
1909	£ 8,791,953	£ 537,552	6.1%	£3,533,000	£671,667	19.0%	£6,849,734	£489,476	7.1%
1910	£13,394,955	£ 516,477	3.8%	£3,393,000	£656,557	19.3%	£7,557,024	£734,214	9.7%
1911	£15,056,685	£ 709,580	4.7%	£4,519,200	£448,260	9.9%	£7,914,831	£734,214	9.3%
1912	£13,828,548	£ 808,360	5.8%	£3,766,969	£661,333	17.5%	£7,833,086	£734,216	9.4%
1913	£13,170,922	£1,020,484	7.7%	£3,991,840	£715,901	17.9%	£7,520,803	£978,952	13.0%
1914	£13,630,433	£1,104,766	8.1%	£4,517,558	£792,177	17.5%	£6,913,852	£930,005	13.4%

Sources: UK Figures Navy estimates 1901-02 - 1914-15. Figures calculated from General summary of estimated direct and indirect expenditure... upon new construction, repairs and alterations' in the case of total construction estimates, and from figures for contract and dockyard construction and further construction each year in the case of submarines.
French and German Figures Brassey's Naval Annual 1893-1914.

British submarine estimates

Breakdown of submarine & total work



Appendix 4

Vickers and the submarine export market, 1900–1913

Demand for submarines increased sharply in the early years of the twentieth century. By 1914 underwater craft were in service with the navies of 18 nations, from Austria–Hungary to Turkey, half of which did not have the facilities to build their own boats. British companies soon attempted to tap the export market for submarines.

Vickers' 1900 agreement with the Electric Boat Co. gave it the right to exploit Holland's patents in Europe. There was considerable initial interest in the design [1]; even French shipbuilders approached Vickers for details of the Holland type [2]. In 1901 Admiral Verhaskoi, head of the Russian Department of Shipbuilding, offered to send a naval officer to inspect a submarine built by Vickers or the EBC in exchange for a 5% 'commission' on boats ordered [3]. Officials from Argentina, Brazil, Chile, Norway and Sweden all made enquiries [4].

From 1901 Vickers publicly rejected all approaches from foreign powers on the grounds that its contract with the Admiralty forbade the export of

[1] Coded telegram, Vickers to ?EBC, 22 January 1901, Vickers papers VP 1003 fol.7, Cambridge University Library

[2] Loewe to Societe Anon. des Forges et Chantiers, Toulon, 10 January 1901 and 26 March 1901, ibid fols. 2–3, 52. The French company had built the submarine *Gymnote* in the 1880s.

[3] Albert Vickers to Basil Zaharoff 19 April 1901, ibid fol.77; Messrs Vickers to Rice 20 April 1901, ibid fol.80

[4] Hall to Fisher 15 June 1910, Fisher papers FP 489, Churchill College Cambridge; Messrs Vickers to Rice 17 September 1901, VP 1003 fol.111; see also ibid fols. 113–14, 118, 138–9

submarine technology while the monopoly agreement remained in force. But the company made several attempts to find the loophole that would enable it to exploit a demand that would otherwise be satisfied by German or French arms firms. The Admiralty was persuaded to authorise the export of two Holland boats and three more sets of engines to Britain's ally Japan, but the IJN soon began to build its own submarines. More significantly, Vickers' 1906 acquisition, jointly with Armstrongs, of the Whitehead torpedo works at Fiume gave it access to a suitable foreign yard over which the Admiralty had no control. In 1907 Vickers told the Norwegian navy that Whitehead could build it Holland submarines [5], and four years later Armstrongs came close to persuading the Brazilians to order boats from the Adriatic yard [6].

Unfortunately for Vickers, foreign governments found the Whitehead works less attractive than British shipyards. Although three prefabricated Holland boats shipped over from the United States were put together there in 1908, and later sold to the KuK Kriegsmarine, Fiume was less experienced and less efficient than Barrow, and even the Austro–Hungarian navy preferred to order extra submarines from the equally inexperienced Krupps [7]. The Whitehead submarine operation was wound up in August 1913 – ostensibly because more space was needed for the manufacture of torpedoes, more probably because there was no likelihood of ever building submarines profitably there. After the war Captain Paul Koster of the Electric Boat Co. observed that the Austrian firm had "balled up the work in a horrible way" [8].

[5] Cf. Messrs Vickers to AE Jones of the Whitehead Company, Weymouth, 10 May 1907, Vickers microfilm 306, Cambridge Univeristy Library

[6] Messrs Armstrongs to Messrs Vickers 20 June 1911, VP 1007 fol.96

[7] Messrs Vickers to AE Jones 10 May 1907, Vickers microfilm 306; Erwin Sieche, 'Austro–Hungarian Submarines', *Warship* V pp.21–3

[8] Koster to EBC 2 August 1919, quoted in Hearings before the Special Committee Investigating the Munitions Industry (Nye committee), vol.1 (1934) p.327, Congressional papers

Appendix 5

Drafting regulations for submarines (1909)

[Source: 'Regulations for the drafting, entry and advancement of men at the Home Ports', chapter III sections 97–101, 7 March 1909, Adm 1/8034.]

[The regulations state that no men in the second class for conduct are to be drafted to service in yachts, cadets' training establishments, boys' training establishments, submarines or torpedo craft.] "...Special rosters for submarine crews are to be kept at each of the three Home Ports, and each port, is to train its own men for the submarines attached to it, a complete crew being provided for each submarine, and in addition one spare crew for every three boats.

All applications by Volunteers are to be forwarded direct to the Inspecting Captain of Submarines, HMS *Mercury*, Portsmouth, accompanied by the Service Certificate, Medical History Sheet, and a statement by Medical Officer as to the candidate's fitness...

Submarine service is to be regarded as a closed service and is to be voluntary. The maximum period of submarine service at one spell, including training, is not to exceed five years without Admiralty approval.

Volunteers are to be entered in the first instance for a nominal period of five years, but they may be allowed to revert to the general service before the end of such a period for purposes of advancement or other legitimate reasons.

Ratings who have served five years, unless specially exempted by the Admiralty, must revert to the general service for at least two years or for a commission, after which they must return to the submarine service.

The total period of service in submarines is not to exceed eight years.

Service in submarines and in spare crews appropriated to submarines is to count as submarine service. Service in submarine depots and bases at home or abroad is not to count as submarine service.

All advancements in the submarine service are to be made only to fill vacancies in that service."

Appendix 6

Distribution of British submarines January 1906

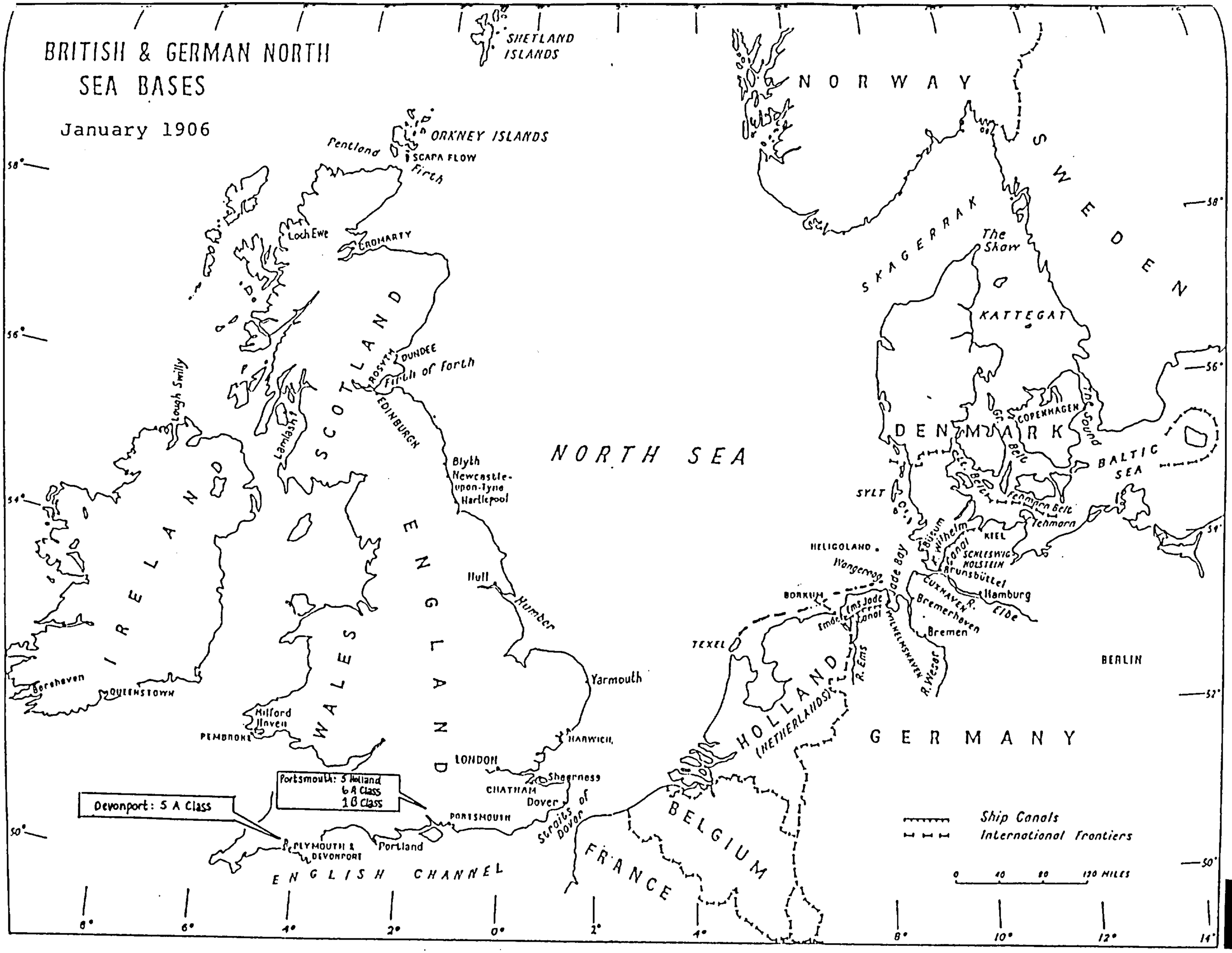
January 1910

July 1914

Showing the major British and German North Sea ports

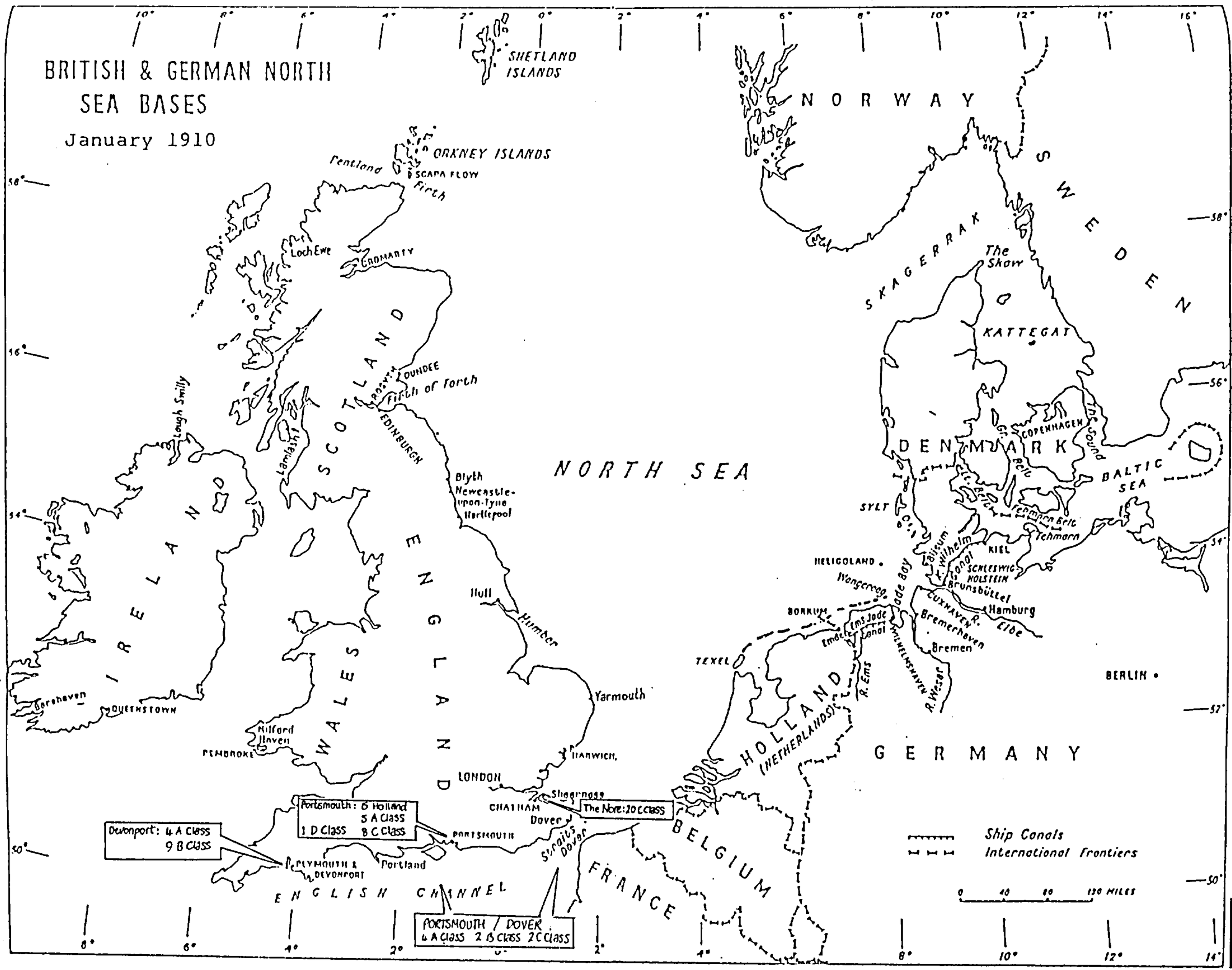
BRITISH & GERMAN NORTH SEA BASES

January 1906



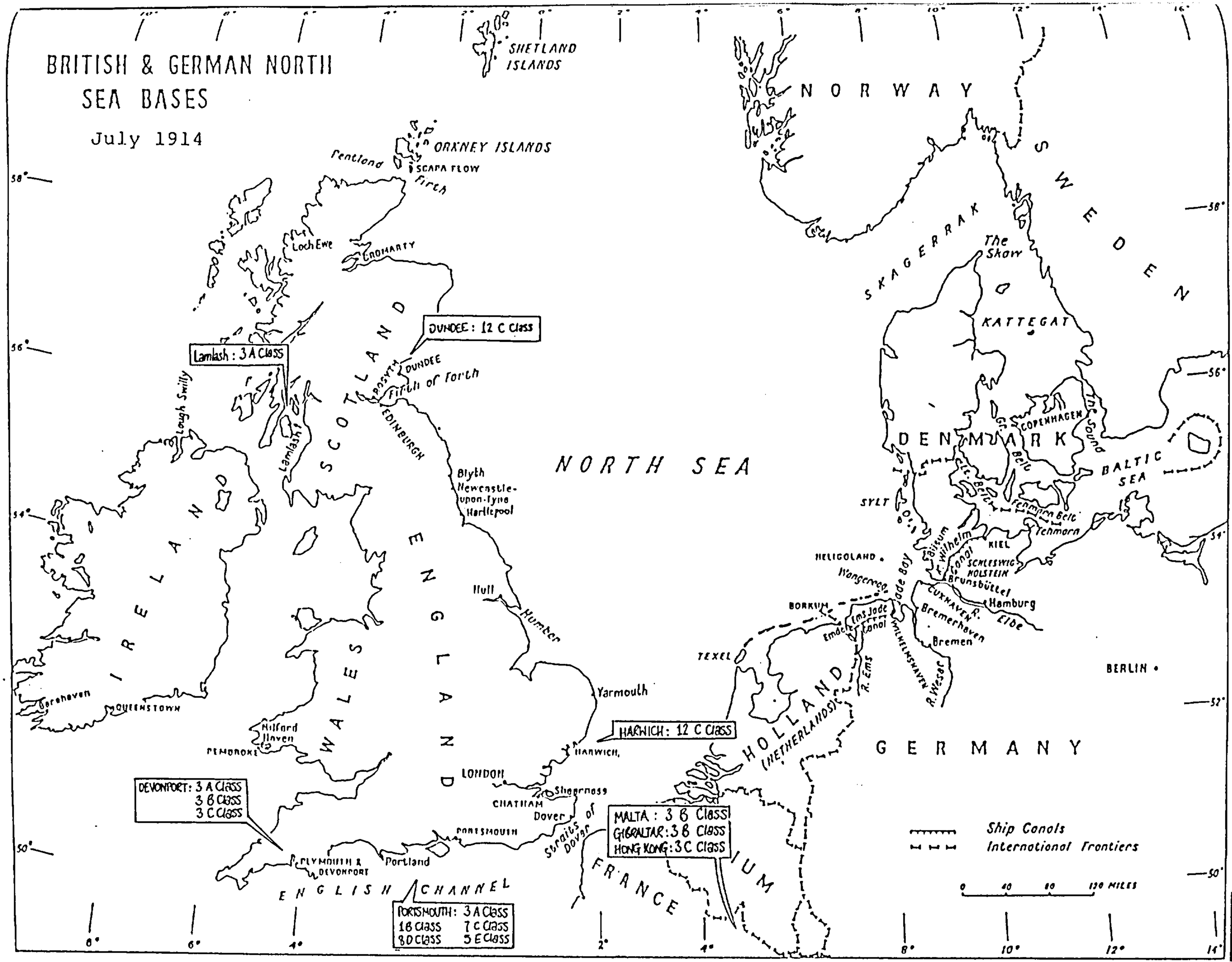
BRITISH & GERMAN NORTH SEA BASES

January 1910



BRITISH & GERMAN NORTH SEA BASES

July 1914



Appendix 7

British submarines: performance in World War I
(Source: Hall report 15 January 1919, Adm 137/2077 fols.109-16)

i) Submarines in commission

Type	On 4 August 1914	On 11 November 1918	Difference
Coastal	42	20	-22
Overseas (patrol)	20	86	+66
Fleet	0	14	+14
Monitor	0	1	+ 1
Anti-submarine	0	6	+ 6
Minelayer	0	6	+ 6
TOTALS	62	133	+71

ii) Officers and ratings in the submarine service

Officers	168	612	+444
Ratings	1,250	5,446	+4,196
TOTALS	1,418	6,058	+4,640

(NB: This represents a percentage increase of 427% in the number of submariners in the service. The respective figures for officers and ratings are: Officers 364%; ratings 436%).

iii) Officers and ratings killed

1914-1918:	Officers	126
	Ratings	1,048
	TOTAL	1,174

(NB: These casualties are equivalent to 83% of the men serving in submarines in August 1914, or 19.4% of the men serving in November 1918. As one would expect the proportion of officers and ratings killed was fairly similar; the casualty figures represent 20.5% of the officers serving at the armistice, and 17.3% of the men.)

iv) Successful actions 1914-1918

Class	Sunk	Hit	Captured	Total
Battleship	2	4	-	6
Battlecruiser	-	2	-	2
Armoured cruiser	1	-	-	1
Light cruiser	2	2	-	4
Destroyer	8	2	-	10
Gun vessels	4	1	-	5
Submarines	20	1	-	21
Armed auxiliaries	7	3	2	12
Transports & unarmed auxiliaries	18	4	-	22
Merchant steamers	50	4	3	57
Sailing ships	207	?	?	207
TOTALS	319	23	5	347

(NB: These are the figures calculated by Hall. I believe they are quite accurate, but have not checked them thoroughly. We now know (see appendix 8) that only 17 U-boats were sunk by British submarines. However, since it is so difficult to tell whether a submarine has dived or gone down after being hit, the discrepancy does not necessarily indicate that other figures are inaccurate. Hall gave no figures for sailing ships hit or captured, but there must have been many of them).

Appendix 8

British submarine losses during the Great War

(Source: *Beneath the Waves: a history of British submarine losses 1904–1971* by AS Evans, London 1986)

Enemy action

Gunfire (German)	1
(Turkish)	2
Nets (Turkish)	1
Mines	5
Probable mine and 'unknown'	18
Submarines (German)	5
Aircraft (Austrian)	1
Total	33

Other causes

Aircraft (French)*	1
Ships (British)*	6
Submarines (British)**	4
Accident	3
Stranding	4
Scuttled during Russian Revolution	7
Blown up at Zeebrugge	1
Total	26

GRAND TOTAL 26

* Mistaken identity
** Collisions, mostly during practice attacks and exercises

German submarine losses during the Great War

(Source: *U–boat intelligence 1914–1918* by RM Grant, London 1968)

Enemy action

Guns	20
Ram	19
Nets and mine–nets	2
Sweeps	2
Depth charge	27
Mine	47
Probable mine and 'unknown'	23
Submarines (British)	17
Submarines (French)	1
Aircraft (British)	1
Total	159

Other causes

German mines	10
German submarines	2
Accident	2
Stranding	5
Total	19

GRAND TOTAL 179

[Note: I have not broken down losses in exactly the same way as Grant, and in some cases have used my discretion in deciding from his evidence what caused a submarine's loss. In case of sinkings caused by multiple attacks, I have selected the weapon which seems to have delivered the coup de grace.]

Bibliography

1) UNPUBLISHED PRIMARY SOURCES

a) Public Records Office, Kew

Admiralty papers

Adm 1 – Secretariat papers. The main bulk of the Admiralty papers is contained in this series, which consists of documents channelled through the Secretary of the Admiralty. Within the Adm 1 series, papers are broken down and catalogued according to source. The 'Admiralty' category is naturally of prime importance, but see also papers marked 'Foreign Office' (for intelligence reports from Consuls and attaches) and 'War Office' (for home defence in the period to 1906). The records of the relevant home ports and stations, and of the Controller's Office (not always preserved) are also useful. Several significant reports, including some from the ICS, can be found under 'Captains A–Z'.

There are six or so boxes per year in the Adm 1 series in the early 1850s, building up to sixty or more for the early years of the twentieth century. From 1914 on there is an adequate PRO index; before that date the researcher is largely on his or her own.

All Admiralty papers have been sifted by the notorious civil service weeders. Every historian delving in the PRO brings away tales of staggeringly capricious weeding. My own: all papers dealing with the 'unimportant' Nordenfelt submarines removed, leaving boxes of files bulging with information on such vital matters as the 'Construction of the RN racquet court at Malta' (Adm 1/6803), the 'Use of capital letters in Printing' (Adm 1/6585) and the protocol governing 'Salutes made by Petty Officers and men when riding bicycles on passing officers' (*sic*!) (Adm 1/7919). On the whole, though, the submarine historian has not been badly served by the weeders, probably because submarine warfare was not sufficiently sensitive for documents to be suppressed for security reasons. The 'Foreign Office' papers, which are of great importance for the Victorian period, seem hardly to have been touched.

Boxes for the period 1800–1919 were examined. Before 1898 and for the 1914–1918 period, PRO indexes and/or the Admiralty digests were used as a guide to likely locations. For 1898–1913 all boxes in the above–mentioned categories were checked as a precaution.

Adm 2 – Admiralty Out letters, 1665–1810

Adm 3 – Admiralty rough minutes, 1793–1839

Adm 12 – Digests and indexes. (Some researchers refer to this class with the now–extinct IND prefix.) All papers which found their way through S–branch were digested and precised in these massive volumes, but letters and submissions addressed to other departments (such as the Surveyor's office) were not, unless the departmental head then made a submission to the Board.

The digests and indexes make up a unique and impressive collection and are an under–exploited resource. They can do far more than simply indicate gaps in the secretariat papers where the weeders have been at work; with patience it is possible to reconstruct entire episodes in naval history from them, and many otherwise lost policy decisions are detailed in their pages.

For the present thesis the digests only were used. The indexes deal with personnel (by name) and would be useful to biographers, but they mostly detail mundane requests for leave and so on.

Submarines were digested under cuts 11a (boats) and 59–8 ('Projects for annoying the enemy', which eventually came to deal with torpedo warfare); the cut 52 (foreign countries) was checked for records of intelligence reports. Volumes for the period 1793–1920 were searched.

Adm 91 and 92 – Surveyor's department records. These large and crumbling volumes, most with their own indexes, record the activities of the Surveyor's department from the Napoleonic Wars to 1860. Adm 91 volumes are letter–books of 'Out' correspondence. The more valuable Adm 92 series contains the Surveyor's 'Recommendation & submission letter books', which include copies of submissions to the Board dealing with the reasons for rejecting particular submarine projects, together with occasional reports by departmental officers on submitted inventions. Volumes for the period 1812–1860 were examined.

Adm 116 – Secretariat papers bound up according to subject. A basic PRO index exists. Large numbers of Adm 116 cases referred to in the digests, including several interesting–looking files on submarines, have been destroyed.

Adm 137 – Papers concerning the Great War which passed through the Historical Section were bound up in the 600–odd page volumes of the Adm 137 series. The Adm 137 papers are mostly routine 'reports of proceedings', but there are a few gems worth searching for. There is a good PRO index and most volumes have their own contents lists. The series includes a ten–volume collection of the wartime records of the Commodore (S). Many duplicates can be found in the volumes detailing the activities of submarines in the Baltic, detached boats based at Blyth–Tees, Harwich and Aberdeen, and vessels under the command of the Admiral of Patrols. These volumes contain docket covers bearing minutes that are not present in the Commodore's records. The 'North Sea' papers of Commodores (S) and (T) also include useful material.

Adm 144 – Station records, Channel Fleet. Used for the manoeuvres of 1904. Partly duplicated in the Adm 1 series.

Adm 189 – Bound printed annual reports of HMS *Vernon*, 1881–on. The series includes an index volume, and each report has its own index.

Adm 231 – Foreign Intelligence Committee and Naval Intelligence Department papers, 1880–1908, with some isolated reports from 1910. This series was recently transferred from the Naval Library, Ministry of Defence, and reports for the period 1908–1914 now seem to be lost.

The Adm 231 series includes intelligence reports on foreign navies, 'Reports on naval affairs', and summaries and analyses of several British manoeuvres.

Cabinet papers

There is a good PRO index to the papers of the Committee of Imperial Defence. The papers themselves (available on microfilm) broadly concern grand strategy and are written in an extremely concise and to–the–point style.

Cab 2 – Minutes of the Committee of Imperial Defence (1902–1914)
Cab 3 – Memoranda on home defence (1901–1914)
Cab 4 – Miscellaneous memoranda (1903–1914)

Foreign office papers

Helpfully bound up in stout volumes, making the weeders' job particulary difficult, and of special importance for the pre–1900 period. Before 1906 there is a rough PRO index by country and consulate. Each consulate submitted reports in the categories 'Political' (after 1872), 'Commercial' and 'Consular'. Submarine papers are invariably included in the 'Political' series; before 1873 this was a sub–section of 'Commerical'.

The FO papers were searched with the aid of the Admiralty digest. Sadly, naval attaches' reports were submitted direct to the Admiralty and do not feature at all before 1906, and only sporadically thereafter; the fortuitous exception that proves the rule is a volume of 1880–2 attache's reports from the United States in the FO 115 series. Particularly useful series include FO 5 (USA) and FO 65 (Russia).

From 1906 all relevant FO papers were catalogued in the FO 371 series. There is a PRO card index to reports.

War office papers

Some documents relevant to the mining and coastal defence debate were found in the 'printed papers' categories, WO 32 and WO 33.

b) Department of Manuscripts, British Library

Halifax papers (Add.Mss. 49531–49593) The papers of Sir Charles Wood, later Lord Halifax, the First Lord of the Admiralty during the Crimean War. Most important are his letter books for the Admiralty period, to which there is a one–volume MS index by name of correspondent.

Arnold–Forster papers (Add.Mss. 50275–50357) The papers of HO Arnold–Forster, Parliamentary Secretary to the Admiralty and later Secretary of State for War during the coast defence debate. They are a

real joy to use; all military and naval documents are meticulously indexed and cross-referenced and almost all the papers – including Arnold-Forster's important diaries – are in typescript.

Balfour papers (Add.Mss. 49683-49962) Most significant for correspondence with Fisher.

Jellicoe papers (Add.Mss. 48989-49057) Rather thin on the ground before 1914, but there are a number of interesting Fisher letters and a few NID reports not to be found in the PRO.

Keyes papers The Keyes papers have not been placed in the 'additional manuscripts' series; they retain the classification system devised at Churchill College, where they were kept until recently. There is a good index, but no substitute for checking the individual files.

The most significant category in KP 4, which deals with Keyes's time with the submarine service and contains an imposing quantity of private and official papers that go far to make up for the paucity of PRO records in the period 1910-1914. Of particular interest is KP 4/22, the Commodore's correspondence with SS Hall.

KP 2, Keyes's correspondence with his wife, begins with their enforced separation in 1914 and continues with a wonderfully candid commentary on events.

Paul Halpern's printed selection of 'Keyes papers' has little submarine material, but is fairly comprehensive for Keyes's career from 1914 onwards.

c) National Maritime Museum, Greenwich

A wealth of material, both official and personal.

The **Adm 138** series deals with the construction history of British warships and is kept in the Draught Room. Each class of submarine from the D class on has a volume or two, while four together cover the earlier boats of the Holland-C classes. A few volumes, such as that for the R class, have gone missing. The papers cover aspects of submarine design and construction (mostly of a purely technical nature), occasionally straying into the realms of policy.

Special permission is needed to consult draught room papers and plans, which include a mass of uncatalogued **Thornycroft** material.

Private papers consulted in the main library include:

Bridge papers Papers of Admiral Sir Cyprian Bridge.

D'Eyncourt papers Papers of Sir Eustace Tennyson d'Eyncourt, the one-time DNC and chief designer at Armstrongs. Includes correspondence with Simon Lake and some stray strategy material from d'Eyncourt's Admiralty years.

May papers Papers of Admiral of the Fleet Sir William May. The papers include reports and analyses of the 1912 and 1913 manoeuvres, which May umpired.

Noel papers Papers of Admiral of the Fleet Sir Gerard Noel.

Phipps Hornby papers The papers of Admiral of the Fleet Sir Geoffrey Phipps Hornby are a valuable source for the early history of the torpedo.

Walker papers Photostat copies of the papers of Admiral Sir Baldwin Wake Walker, Surveyor of the Navy in the 1850s.

d) Churchill College archives centre, Cambridge

Appointments are preferred at this important centre for 20th century political and naval history. Notable collections include:

Fisher papers 6,000−odd items indexed by author but not by subject. The papers rank among the most important private sources for the history of the submarine. Fisher's archive contains invaluable correspondence with SS Hall as well as his own idiosyncratic papers on the subject.

McKenna papers Papers of Reginald McKenna, First Lord 1908−1911.

Tomkinson papers A four−volume war diary and forty or so letters from Keyes preserved by the Commodore's close friend and long−time lieutenant.

e) Department of manuscripts, Cambridge University Library

Graham papers Papers of Sir James Graham, First Lord 1830−34 and 1852−55 (on microfilm).

Vickers papers Transferred from Vickers House in 1984. Of great interest, but apparently weeded since being used by Scott and Trebilcock, the Vickers historians, whose references no longer correspond to the arrangement of the papers. Some material is on microfilm or bound up with the extensive collection of material made available to the Bankes Commission. There is an index volume and a few of the letter books are indexed by addressee.

f) Tyne and Wear archives centre

Armstrong papers Papers of the great Armstrong arms combine. Special permission is needed to consult them.

g) Southampton University Library

Palmerston papers The thoroughly−indexed Broadlands Mss., recently transferred from the National Registry of Archives, contain correspondence from Sir Charles Wood, the Prince Consort and John Scott Russell. Includes the exceptionally interesting 'Journal of the submarine vessel, 1855'. Is this the world's oldest surviving submarine log?

h) Naval Library, Ministry of Defence

Located in the Empress State Building, Earl's Court. Two boxes of Tweedmouth papers (indexed), a collection of printed Selborne papers, a

volume of pre-war naval attache's reports from Berlin, the multiple-volume Admiralty 'Technical history' of the Great War, and numerous unique typescripts (including a partial translation of the German official history of the war) are among the more important documents. The library also holds an unrivalled collection of books, pamphlets and offprints dealing with all aspects of naval history. Appointment necessary in the first instance.

A less important collection than it once was, thanks to the transfer of many original papers to the PRO.

i) Imperial War Museum

Talbot papers The extensive diaries of Vice Admiral Sir Cecil Talbot, one of the pioneer submariners, provide details of his service in the submarine branch from 1905 to 1918.

The Imperial War Museum library also boasts an imposing collection of military books and journals. An appointment is necessary.

j) Submarine museum archives, HMS Dolphin, Gosport

A wide variety of papers (original material and photostats, including a few **Addison papers**), press clippings and sound archives are held by the submarine museum, and researchers can also tap the invaluable knowledge of its curators. The emphasis is more on operations than on policy.

At the time of writing, HM Submarine *Holland No.1* is on display at the museum, and preparations are being made for the salvage of the conning tower of the wartime boat *E17*.

An appointment is necessary to visit the archives centre, which is located inside a naval base, although the museum itself is open to the public.

k) New York Public Library

The rare books room holds primary material concerning the Confederate submarine service, while the reading room offers a mass of American secondary sources – many of them not available in the UK.

2) PUBLISHED PRIMARY SOURCES – OFFICIAL

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